THE

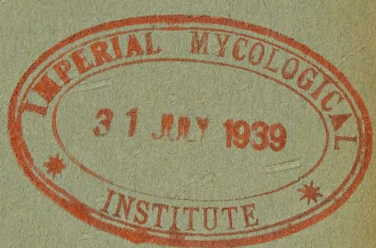
Tea Research Institute

OF

Ceylon.

BULLETIN No. 19

Annual Report for the Year 1938.



Published by

THE TEA RESEARCH INSTITUTE OF CEYLON,
ST. COOMBS, TALAWAKELLE.

The Tea Research Institute of Ceylon.

BOARD OF CONTROL

(A) Representing the Planters' Association of Ceylon :—

(1) Mr. R. G. Coombe (on leave) Mr. Gordon Pyper (acting).

(2) Mr. Jas. Forbes, (Chairman)

(3) Mr. J. D. Hoare

(B) Representing the Ceylon Estates Proprietary Association :—

(4) Major J. W. Oldfield, C.M.G., O.B.E., M.C.

(5) Mr. I. L. Cameron

(6) Mr. J. C. Kelly

(C) Representing the Low-Country Products' Association :—

(7) Mr. S. F. H. Perera

(D) Representing the Small-Holders :—

(8) Mr. T. B. Panabokke

(E) Ex-Officio Members :—

(9) The Hon. the Financial Secretary.

(10) The Director of Agriculture

(11) The Chairman, Planters' Association of Ceylon

(12) The Chairman, Ceylon Estates Proprietary Association

Secretary, Roland V. Norris, D.Sc., St. Coombs, Talawakelle.

THIRTEENTH ANNUAL REPORT

OF THE

BOARD OF THE TEA RESEARCH INSTITUTE OF CEYLON

FOR 1938.

Foundation.—The Tea Research Institute of Ceylon was established by Ordinance No. 12 of 1925, dated the 27th October, 1925.

Past Chairmen of the Institute.

Name	Date of Appointment	Date of Resignation
Major J. W. Oldfield, C.M.G., O.B.E., M.C.	7th January, 1926	24th November, 1926
Mr. John Horsfall	24th November, 1926	14th April, 1927
Mr. R. G. Coombe	14th April, 1927	9th April, 1929
Major J. W. Oldfield, C.M.G., O.B.E., M.C.	9th April, 1929	30th September, 1929
Mr. C. Huntley-Wilkinson	30th September, 1929	28th November, 1929
Mr. R. G. Coombe	29th November, 1929	7th April, 1932
Mr. G. K. Stewart	7th April, 1932	26th November, 1932
Mr. R. G. Coombe	26th November, 1932	13th January, 1934
Mr. James Forbes	13th January, 1934	31st October, 1936
Mr. R. G. Coombe	31st October, 1936	2nd June, 1937
Mr. James Forbes	2nd June, 1937	

BOARD OF MANAGEMENT.

The constitution of the Board is laid down in the Ordinance; the personnel on the 1st January, 1938, was :—

Ex-Officio Members.

The Hon'ble the Financial Secretary (Hon. Mr. H. J. Huxham).
The Director of Agriculture (Mr. E. Rodrigo).
The Chairman, Planters' Association of Ceylon (Mr. R. P. Gaddum).
The Chairman, Ceylon Estates Proprietary Association (Mr. D. T. Richards).

Representatives of the Planters' Association of Ceylon.

Mr. James Forbes (Chairman).
Mr. R. G. Coombe.
Mr. J. D. Hoare.

Representatives of the Ceylon Estates Proprietary Association.

Major J. W. Oldfield, C.M.G., O.B.E., M.C.
Mr. I. L. Cameron.
Mr. J. C. Kelly.

Representative of the Low-Country Products Association.

Col. T. G. W. Jayewardene, V.D.

Representative of the Small-Holders.

Mr. T. B. Panabokke.

Chairman.—Mr. James Forbes.

Secretary.—Dr. Roland V. Norris.

Solicitors.—Messrs. Julius & Creasy.

Auditors.—Messrs. Ford, Rhodes, Thornton & Co.

Registered Office.—The Victoria Commemoration Buildings, Kandy.

The Chairman, T. R. I.—Mr. James Forbes was the Chairman of the Board throughout the year.

Members of the Board.—Mr. R. C. Scott became an ex-officio member of the Board as from 18th March on his election to the Chairmanship of the Planters' Association of Ceylon, *vice* Mr. R. P. Gaddum.

Mr. R. J. Hartley on his election as Chairman of the Ceylon Estates Proprietary Association became an ex-officio member as from the 5th August, *vice* Mr. D. T. Richards vacated.

Mr. S. F. H. Perera was nominated by the Low-Country Products Association to serve as their representative on the Board as from the 25th September *vice* Colonel T. G. W. Jayewardene, V.D. whose term of appointment expired as from the 24th of that month.

Major C. E. Hawes was nominated by the Ceylon Estates Proprietary Association to act for Mr. I. L. Cameron during the absence on leave of the latter from the 16th March to the 15th July.

Mr. K. W. Taylor was nominated by the Ceylon Estates' Proprietary Association to act for Mr. J. C. Kelly during the absence on leave of the latter from the 22nd April to 9th November.

Mr. R. G. Coombe's nomination as a representative on the Board of the Planters' Association of Ceylon was renewed for a further period of three years as from 1st January, 1938.

MEETINGS OF THE BOARD.

Four meetings of the Board were held during the year, all in Colombo, the average attendance being 10.

AUDITORS.

Messrs. Ford, Rhodes, Thornton & Co. continued to act as the Institute's Auditors.

COMMITTEES.

The following were the principal Committees in 1938 :—

Finance Committee.—The Chairman, T. R. I., the Chairman, Planters' Association of Ceylon, the Chairman, Ceylon Estates Proprietary Association, Major J. W. Oldfield, C.M.G., O.B.E., M.C., Mr. J. D. Hoare, Mr. J. C. Kelly and the Director, T. R. I.

Mr. K. W. Taylor acted for Mr. Kelly during the latter's absence on home leave.

Estate and Experimental Sub-Committee.—The Director, T. R. I. (Chairman), the Chairman, T. R. I., the Visiting Agent (Mr. H. Tonks), the Superintendent, St. Coombs, Messrs. R. G. Coombe, J. Horsfall, C. H. Wilkinson, D. T. Richards, R. H. Horne, J. T. Young, F. J. Whitehead and Dr. F. R. Tubbs (Secretary).

Mr. J. Horsfall resigned from the Committee on his retirement from Ceylon.

This Committee held four meetings during the year.

Medical Scheme Sub-Committee.—The Chairman, T. R. I., the Director, T. R. I., Mr. G. D. Austin, (representing the Junior Staff).

Trustees of Junior Staff Provident Fund.—The Chairman, T. R. I., the Director, T. R. I., Mr. R. G. Coombe, and Mr. E. N. Perera (representing the Junior Staff).

Visiting Agent.—Mr. H. Tonks continued as Visiting Agent and paid two visits of inspection to St. Coombs Estate during the year.

ST. COOMBS ESTATE.

Though rainfall was somewhat in excess of that for 1937, distribution was irregular. Particularly unfavourable weather in September, associated with high wind and almost total lack of sunshine and followed by very scanty

North-East Monsoon rains, delayed recovery of pruned fields, and led to a substantial reduction in crop. The latter amounted to 173,721 lbs. against an estimate of 185,000 lbs.

Including two experimental invoices sold in London the average price realised was 80.28 cents gross or 75.23 cents nett. The average price obtained for high grown teas on the Colombo market was 79 cents gross.

The profit on estate working account amounted to Rs. 41,152 against an estimate of Rs. 40,000.

ESTATE SCHOOL.

Favourable inspection reports were received on the Estate School, and a grant amounting to Rs. 518/- was obtained from Government.

FINANCE.

The total receipts for the year amounted to Rs. 379,856 made up as follows : Cess Rs. 334,705/-, Profit on Estate Working Account Rs. 41,152/-, Interest and Miscellaneous Receipts Rs. 3,999/-.

Expenditure on Revenue Account, including depreciation at Rs. 38,331/- and Interest Charges on Government Loan at Rs. 42,898/-, amounted to Rs. 307,330/-. There was therefore a surplus on Revenue Account for the year amounting to Rs. 72,526/-.

Capital Expenditure amounting to Rs. 76,833 was incurred, this sum being made up of Rs. 44,855/-, Capital Expenditure on Assets, and Rs. 31,978 repayment of the Government Loan.

Total liquid assets as at 31st December, 1938, after providing for specific liabilities such as accrued interest on the Government Loan and Furlough and Passages Reserve, amounted to Rs. 198,715 equivalent to 65.4 per cent of the liability under the Depreciation Reserve which at the same date amounted to Rs. 319,115.

The question of the renewal of the Research Cess at 14 cents per 100 lbs. of tea exported was considered by the State Council in December when it was unanimously agreed to continue the cess at this rate until the 31st December, 1943.

PUBLICATIONS.

The Institute's publications are sent free of charge to Proprietors, Directors, Superintendents and Assistant Superintendents of all Ceylon Tea Estates of over 10 acres in extent and to London and Colombo Agency Firms dealing with tea if they register their names with the Secretary.

Other persons can obtain the publications on payment of an annual subscription of Rs. 15/- per annum if resident in Ceylon or India, and £1-5-0 if resident elsewhere.

Single numbers of *The Tea Quarterly* or Bulletins can be obtained for Rs. 2-50 or 4 shillings per copy.

The average distribution during 1938 amounted to 1,620 copies. This comprised 1,310 copies issued to Estates and Proprietary Interests, 74 issued to Libraries and Scientific Institutes, usually in exchange for other scientific publications, and 236 copies to private subscribers.

Rs. 3,973 was received by way of subscriptions and Rs. 3,400 from advertisements. As a result of these receipts there was a profit on publications for the year of Rs. 3,063.

The following publications were issued during the year :—

The Tea Quarterly, Vol. XI, Parts I-IV.

Bulletin No. 18, Annual Report for 1937.

ACKNOWLEDGMENTS.

Close co-operation has been mainained as usual with the Ceylon Association in London, the Ceylon Estates Proprietary Association, the Planters' Association of Ceylon, and other bodies concerned in the Tea Industry and the thanks of the Institute are due to these Associations for their support in regard to the renewal of the research cess at its present rate.

Thanks are due to the Ceylon Chamber of Commerce, Colombo, for the use of their Board Room for meetings of the Board held in Colombo.

The Audited Statement of Accounts and Balance Sheet for 1938 are included.

ROLAND V. NORRIS,
Secretary.

THE TEA RESEARCH INSTITUTE OF CEYLON.

BALANCE SHEET AS AT 31st DECEMBER, 1938.

LIABILITIES

	Rs. Cts.	Rs. Cts.
CREDITORS & CREDIT BALANCES:—		
Accrued Interest on Loan ...	10,394.84	
Suspense Account ...	49.45	
Ceylon Association in London ...	279.84	
Sundry Creditors—Research ...	5,990.68	
Sundry Creditors—Estate ...	6,660.75	
Subscriptions for Publications Received in Advance ...	94.41	23,469.97
FURLOUGH RESERVE :—		
At 31st December, 1937 ...	15,708.79	
Additions during 1938 ...	4,854.00	
...	20,562.79	
Deduct : Payments during 1938 ...	4,823.01	15,739.78
DEPRECIATION RESERVE:—		
At 31st December, 1937 ...	281,915.41	
Credited at 31st December, 1938...	37,199.46	319,114.87
Carried forward		Rs. 358,324.62

ASSETS

		Rs. Cts.	Rs. Cts.
DEBTORS & DEBIT BALANCES:—			
Controller of Finance & Supply ...		25,355.22	
Refund of Income Tax on £2,063.18.1 4% Funding Loan		151.33	
SUNDRIES RESEARCH:—			
Research Staff	2,584.20		
Sundry Debtors A/c Advertising	955.00		
Accrued Interest on Fixed Deposits	644.14		
	4,183.34		
SUNDRIES ESTATE	988.60	5,171.94	30,678.49
STOCK-IN-HAND:—			
Tea—18,289 lbs.		12,936.30	
Estate Rice	1,906.28		
Packing Materials	2,865.12	4,771.40	17,707.70
INVESTMENTS:—			
£2,300. 0.0 3½% War Loan			32,434.76
£2,063.18.1 4 % Funding Loan			29,928.06
Rs. 30,000, 3½% Ceylon Government Loan			29,512.50
Carried forward			Rs. 140,261.51

BALANCE SHEET AS AT 31st DECEMBER, 1938.—*(Contd.)*

LIABLITIES		ASSESTS	Rs. Cts.		Rs. Cts.
Brought forward	Rs. 358,324.62	Brought forward			140,261.51
		CASH:—			
		Research Fixed Deposit	39,620.00		
		Current Account	51,857.79		
		In Hand	424.19	91,901.98	
		Estate— N. B. I. Ltd., Colombo	6,535.13		
		,, in Hand	13.36	6,548.49	98,450.47
		FUNDS OVERSPENT TO 31st December 1937		115,306.04	
		Capital Expenditure 1938		44,855.13	
		Repayment of Govt. LOAN 1938		31,977.61	
				192,138.78	
		Less: Revenue applied for capital purposes, being revenue account surplus for the year 1938		72,526.14	119,612.64
	Rs. 358,324.62				Rs. 358,324.62

We have audited the books of the Tea Research Institute of Ceylon for the year ended 31st December, 1938.

The allocations of Capital Expenditure and of Research Revenue Expenditure as made by the Director have been accepted by us.

We are not in a position to say whether the Reserves made for Depreciation are adequate.

Subject to the foregoing reservation, we certify that, to the best of our belief, the above Balance Sheet presents a true and correct view of the financial affairs of the Institute at 31st December, 1938 according to the information and explanations given to us and as shown by the books.

(Sgd.) FORD, RHODES, THORNTON & CO.
Chartered Accountants

Colombo, 14th March 1939.

THE TEA RESEARCH INSTITUTE OF CEYLON.

Dr. **CAPITAL ACCOUNT AS AT 31st DECEMBER, 1938** **Cr.**

EXPENDITURE

	To 31-12-37 Rs. Cts.	Additions in 1938 Rs. Cts.	Deduct cost of Assets sold or scrapped in 1938 Rs. Cts.	Total Rs. Cts.
To Land Including Development	810,520.61	17,396.56	—	827,917.17
,, Buildings and Lines	873,522.16	21,293.31	—	894,815.47
,, Furniture and Equipment	78,108.22	156.84	45.00	78,220.06
,, Laboratory Equipment	38,752.16	2,424.44	69.34	41,107.26
,, Experimental Machinery	25,691.39	—	—	25,691.39
,, Machinery Estate	124,320.78	5,455.23	1,931.91	127,844.10
,, Motor Car	4,325.00	4,500.00	4,325.00	4,500.00
,, Motor Road Roller	7,386.03	—	—	7,386.03
Rs.	1,962,626.35	51,226.38	6,371.25	2,007,481.48

RECEIPTS

	Rs. Cts.	Rs. Cts.	Rs. Cts.
By Government of Ceylon:— Loan on Mortgage at 5½% per annum		1,000,000.00	
Less: Repayments to 31-12-37	212,034.27		
Payment 1938	31,977.61	244,011.88	755,988.12
,, Revenue Applied to Capital Purposes to 31st December 1937		1,059,354.58	
do 1938		72,526.14	1,131,880.72
,, Funds Overspent to 31st Dec. 1937		115,306.04	
During 1938		4,306.60	119,612.64
			Rs. 2,007,481..48

THE TEA RESEARCH INSTITUTE OF CEYLON.

ESTATE WORKING ACCOUNT FOR THE YEAR ENDED 31st DECEMBER, 1938.

EXPENDITURE		Rs. Cts.	INCOME		Rs. Cts.
To Estate Revenue Expenditure	...	91,008.97	By Tea Sales—Local	172,965 lbs.	138,866.96
,, Charges—Export Duty, Etc.	...	8,740.38	,, Do —Factory	458 ,	356.63
,, Balance Carried Forward	...	41,151.75	,, Do —Broken Mixed	2,930 ,,	439.50
			,, Do —Biochemical Department	298 ,,	133.15
			,, Motor Road Roller Account		1,104.86
		Rs. 140,901.10			Rs. 140,901.10

REVENUE ACCOUNT AS AT 31st DECEMBER, 1938.

Dr. **Cr.**

	Rs. Cts.	Rs. Cts.		Rs. Cts.
To Administration of the Board:—			By Balance from Estate Working Account	41,151.75
Planters' Association of Ceylon	240.00			
Travelling Expenses of Board	2,034.16		,, Tea Cess	334,704.65
Clerical Staff ...	5,973.11			
Telephone Operators ...	948.00		,, Interest	3,937.34
Office Peon ...	600.00			
Postages ...	734.47		,, Rent of Caddy	60.00
Stationery ...	1,191.63			
Advertising ...	74.33		,, Miscellaneous Receipts	2.56
Telegrams, Trunk Calls etc.	306.62			
Printing ...	120.30			
Legal Charges ...	10.50			
Auditors' Fees ...	701.64			
Contingencies ...	201.18	13,135.94		
Carried forward		Rs. 13,135.94	Carried forward	Rs. 379,856.30

THE TEA RESEARCH INSTITUTE OF CEYLON.

Dr. **REVENUE ACCOUNT AS AT 31st DECEMBER, 1938.**—*(Contd.)* **Cr.**

			Rs. Cts.		Rs. Cts.
	Brought forward		13,135.94	Brought forward	379,856.30
To Personal Emoluments of Scientific Staff:—					
Director	...	22,500.00			
Mycologist	...	19,500.00			
Agricultural Chemist	...	17,524.20			
Entomologist	...	16,837.10			
Plant Physiologist	...	14,947.06			
Tea Technologist	...	11,330.36	102,638.72		
,, Emoluments of Junior & Sub. Scientific Staff:—					
Junior Scientific Staff	...	33,819.28			
Subordinate Scientific Staff	...	4,059.04	37,878.32		
,, Laboratory:—					
Equipment and General Working Expenses	...	5,910.25			
Furniture and Office Equipment		178.69	6,088.94		
,. Library and Publications:—					
Library	...	2,255.68			
Publications	...	Cr. 3,063.18	Cr. 807.50		
Carried forward			Rs. 158,934.42	Carried forward	Rs. 379,856.30

Dr. **REVENUE ACCOUNT AS AT 31st DECEMBER, 1938.**—*(Contd)* **Cr.**

	Rs. Cts.	Rs. Cts.		Rs. Cts.
Brought forward		158,934.42	Brought forward	379,856.30
To SMALL-HOLDINGS:—				
Salaries and House Allowances	5,637.65			
Travelling and General Expenditure	2,626.68	8,264.33		
,, TRAVELLING OF STAFF:—				
Officers' Expenses	4,057.86			
Insurance of Car	156.96			
Entertainment Allowance	355.00			
Drivers' Wages	1,262.74			
Drivers' Batta	374.82			
Running Expenses	3,378.50	9,585.88		
,, FIELD AND FACTORY EXPERIMENTS:—				
Agricultural Chemist	3,588.03			
Plant Physiologist	4,306.24			
Miscellaneous Field Experiments	282.94			
Factory Experiments	3,223.81	11,401.02		
,, MAINTENANCE OF BUILDINGS:—				
Laboratory	186.93			
Six Senior Staff Bungalows	1,522.53			
Eleven Junior Staff Bungalows	1,559.24			
Clerks' Bungalows	625.90			
Miscellaneous Lines & Buildings	225.60	4,120.20		
,, GENERAL SERVICES:—				
Electric Power	4,140.00			
Mechanic	867.30			
Telephone Rent and Maintenance of Lines	568.50			
Roads	804.71			
Sanitation	706,30			
Water Supply	1,389.87			
Tappal Lorry & Book Fees	234.00			
Nettikans and Drains	25.80			
Upkeep of Grounds	826.13	9,562.61		
		201,868.46	Carried forward	379,856,30

THE TEA RESEARCH INSTITUTE OF CEYLON.

REVENUE ACCOUNT AS AT 31st DECEMBER, 1938—(*Contd*)

Dr. **Cr.**

	Rs. Cts.	Rs. Cts.
Brought forward		201,868.46
To MISCELLANEOUS:—		
Incidentals	211.31	
Ceylon Planters' Provident Society	10,263.87	
Provident Fund, Junior Scientific Staff	3,834.63	
Provident Fund, Clerical and Subordinate Staff	1,296.56	
Passages	3,750.00	
Ceylon Nursing Assn. and Fraser Nursing Home	180.00	
Medical Fees, Subordinate Staff	255.48	
Medical Scheme, Junior Staff	1,146.00	
Insurances	2,317.98	
Watchmen and Caretakers	612.88	
Rentals	363.26	24,231.97
		226,100.43
To GOVERNMENT OF CEYLON LOAN INTEREST ACCOUNT		42,898.36
,, DEPRECIATION ACCOUNT		38,331.37
,, BALANCE		72,526.14
	Rs.	379,856.30

	Rs. Cts.
Brought forward	Rs. 379,856.30
	Rs. 379,856.30

LOAN ACCOUNT

Dr. **Cr.**

		Rs. Cts.	Rs. Cts.
To GOVERNMENT OF CEYLON	Rs. 1,000,000.00	By REPAYMENTS PRINCIPAL:—	
		1st Instalment 1929	18,227.00
		2nd ,, 1930	19,320.72
		3rd ,, 1931	20,479.00
		4th ,, 1932	21,708.60
		5th ,, 1933	23,011.09
		6th ,, 1934	24,391.74
		7th ,, 1935	25,855.23
		8th ,, 1936	28,730.36
		9th ,, 1937	30,310.53
		10th ,, 1938	31,977.61 244,011.88
		Balance	755,988.12
March 14, 1939,	Rs. 1,000,000.00		Rs. 1,000,000.00

METEOROLOGICAL OBSERVATIONS, 1938.

ST. COOMBS.

Month	Temperature				Mean Relative Humidity	Rainfall Inches	No. of Rainy days	Sunshine
	Mean Max.	Mean. Min.	Adopted Mean.	Mean on Grass				hrs. mts.
January	74.8	57.8	66.3	50.1	70	1.41	7	204 13
February	77.0	57.1	67.1	49.4	68	5.88	13	189 19
March	76.9	58.0	67.5	52.2	78	4.81	20	171 54
April	77.4	59.4	68·4	55.5	79	4·83	17	175 10
May	76.1	61.0	68·6	58.2	82	3.47	14	190 07
June	70.1	60.6	65.4	58.3	86	21.03	26	88 22
July	71.3	58.8	65.1	54.0	84	20.63	25	135 32
August	72.7	59·7	66.2	57.2	84	5.36	25	113 05
September	71.6	59.9	65·8	57.9	85	13.83	29	99 14
October	73.7	56.8	65.3	52·2	78	5.24	14	165 35
November	74.4	55.7	65.1	50.1	76	5.10	11	209 52
December	73.9	57.4	65.7	52.8	76	5.59	19	146 24
Annual	74.2	58.5	66.4	54.0	79	97.18	220	1888 47
			Means				Totals	

REPORT

ON

ST. COOMBS ESTATE

FOR 1938.

Superintendent.—Mr. J. A. Rogers.

ACREAGE STATEMENT.

	A.	R.	P.
Tea in Bearing ...	264	1	06
New Clearings 1937 ...	20	0	00
New Clearings 1938 ...	16	0	00
Tea Nurseries ...	1	1	08
Fuel Clearings ...	27	0	00
Reserve Land available for planting	27	1	09
Building Sites ...	26	2	22
Waste Land, Swamps, etc. ...	32	1	14
Total Acreage ...	414	3	19

Climate.—Rainfall registered in 1938 — 97.18 inches, on 220 days.
Rainfall registered in 1937 — 85.42 inches, on 209 days.

Rainfall was erratic in the South-West Monsoon, and this was followed by a partial failure of the North-East Monsoon, with low rainfall in October and November.

Crop.—Total crop harvested in 1938—173,721 lbs. Estimated 185,000 lbs.
Total crop harvested in 1937—172,226 lbs. Estimated 160,000 lbs.

Increase in 1938— 1,358 lbs.

Yield per acre in 1938—657 lbs. on 264 acres.
Yield per acre in 1937—652 lbs. ,, ,, ,,

PRICES.

Colombo Sales.—The average for High Grown Teas sold on the Colombo Market in 1938 was 79 cents, as compared with 82 cents in 1937.

St. Coombs.—Gross average in 1938—80.28 cents per lb.*
Gross average in 1937—82.02 cents per lb.
Nett average in 1938—75.23 cents per lb.*
Nett average in 1937—77.30 cents per lb.

* Includes two invoices sold in London.

Cost of Production.

1938—52.39 cents per lb.—Estimate 52.64 cents per lb.
1937—51.92 cents per lb.—Estimate 57.09 cents per lb.

Profit on Estate Working Account.

1938—Rs. 41,152/-, which is equivalent to Rs. 156/- per acre.
1937—Rs. 42,769/-, which is equivalent to Rs. 162/- per acre.

Cultivation—was carried out according to programme.

A trial is to be started in 1939 to extend the Pruning Cycles to 4 years, with slightly increased manuring.

Green Manures.—*Crotalaria anagyroides* has been used this year in rotation, instead of *Tephrosia vogelii*, owing to eelworm attack, but it was not found altogether satisfactory; different times and methods of sowing are to be tried out, and seed will not be sown till August and onwards to avoid attack by Capsid Bug which usually occurs from April to June.

Diseases.—There have again been no serious attacks of Tea Tortrix.

Phloem necrosis has been identified in some fields, though very few advanced cases have been discovered.

Tea Nurseries.—One section of the nurseries has been thoroughly re-conditioned and replanted.

New Clearings.

1937 Clearing 20 Acres.—The phenomenally bad planting weather in 1937 resulted in a very high percentage of failures, which were supplied in 1938, last year's successful plants are doing quite satisfactorily.

1938 Clearing 16 Acres.—This clearing has been opened on the modified contour system, and was planted 4 feet × 2 feet, (except for the two experimental plots), and the whole clearing worked out at about 3,900 holes per acre.

The estate, from which plants had been booked, was unable to supply the order, and consequently some 25,000 holes were planted with stumps procured elsewhere, and the remaining 37,500 holes were planted with seed-at-stake.

The weather this year has again been far from favourable for planting, and owing to the mildness of the North-East Monsoon, this will probably result in a large percentage of failures in this clearing, which is unfortunate.

The clearing was extremely well opened. This modified contour system involves a large amount of difficult work, which was energetically tackled by Mr. Rogers.

Funds have been provided in 1939 estimates to establish ground covers, and for other anti-erosion methods to be carried out in the 1937 and 1938 clearings.

Labour.—At the end of 1938 there were 410 working labourers on the estate, (an increase of 31 over the figures for 1937). This is equivalent to 1.55 labourers per acre in bearing.

The labour position is now satisfactory for present requirements, though of course the opening of clearings in 1937 and 1938 required labour, which could otherwise have been advantageously utilized on the estate.

The following figures indicate the large demand for estate labour by the Institute, new clearings, and other requirements during 1938.

Labour for Tea Research Institute work		12,220 labourers.
Lent Labour for T. R. I. Staff	...	2,422 ,,
Labour used on 1937 Clearing	...	2,727 ,,
Labour used on 1938 Clearing	...	5,302 ,,
Total	...	22,671 labourers.

Manufacture, Etc.—A new 34 inches C.C.C. single action roller, with automatic electric pressure gears, has been installed during the year. This additional roller enables required rolling programmes to be undertaken satisfactorily without overloading at any stage.

The C.C.C. "Multiple" green leaf sifter has recently been replaced by a C.C.C. horizontal rotary green leaf sifter and roll-breaker.

Manufacture throughout is carried out under thoroughly hygienic conditions.

General.—The manuring and cultivation programmes are satisfactory and have been well carried out.

The estate is in good order, and in spite of the estimated crop not being harvested, the estimated profit has been obtained.

Mr. Rogers proceeds in April on a well-earned leave, and Mr. N. B. Parker will act on St. Coombs during his absence.

HUBERT TONKS,

Visiting Agent.

REPORT

OF

THE DIRECTOR,

TEA RESEARCH INSTITUTE OF CEYLON

FOR 1938.

Administration.—The administrative arrangements in force in the previous year were continued without change.

Finance.—Exports of Ceylon tea during the period January-December, 1938, were higher than anticipated. In consequence, the receipts from the Research Cess, which remained at 14 cents per 100 lbs. of tea exported, amounted to Rs. 334,705/- against an estimate of Rs. 321,320/-.

The receipts from St. Coombs Estate, on the other hand, were slightly lower than in 1937, Rs. 41,152/- as against Rs. 42,290/-. With miscellaneous receipts at Rs. 3,999/-, the total revenue for the year amounted to Rs. 379,856/-, the figure for 1937 being Rs. 344,712/-.

Expenditure on laboratory revenue account, excluding depreciation and interest charges on the Government Loan, amounted to Rs. 226,101/-, the estimate for the year being Rs. 235,241/-. After making provision for depreciation of Rs. 38,331/- and meeting interest charges on the loan amounting to Rs. 42,898/-, the surplus on general revenue account for the year was Rs. 72,526/- as against Rs. 47,072/- in 1937.

Capital expenditure was incurred amounting to Rs. 76,833/-, distributed as follows: Repayment of Government Loan Rs. 31,978/-; Lines and Buildings Rs. 21,293/-; Land Developments Rs. 17,396/- and Machinery and Equipment Rs. 6,165/-. Under Buildings the major item was the cost of the new Guest House, Rs. 18,000/-.

Liquid assets as at 31st December, 1938, after allowing for liabilities to creditors, accrued interest on the Loan and the Furlough and Passages Reserve, amounted to Rs. 198,715/-. The liability under the Depreciation Reserve at the same date amounted to Rs. 319,115/-, so that the latter was represented in cash to the extent of 65.4 per cent.

Research Cess.—Under Ordinance No. 8 of 1934 the Research Cess was fixed at 14 cents per 100 lbs. of tea exported up to 31st December, 1938. In view of the fact that tea restriction was imposed for a further period of five years, the Institute proposed to the interests

concerned that the 14 cents rate of cess should be renewed up to the 31st December, 1943. This proposal was approved by the Ceylon Association in London, the Ceylon Estates Proprietary Association and the Planters' Association of Ceylon and finally received the sanction of the Ceylon State Council in December last.

St. Coombs Estate.—The rainfall for the year, 97.18 inches falling on 220 days was about 12 inches in excess of that for 1937. Distribution was however unfavourable. Unseasonable rain fell in February and March while exceptionally severe weather was experienced in September and this was followed by a partial failure of the North-East Monsoon in the last three months of the year. Pruned fields were in consequence slow in coming away and the crop harvested amounted to 173,721 lbs. against an estimate of 185,000 lbs.

The unfavourable weather was also most detrimental to the success of a clearing of 16 acres which was opened on the modified contour system and planted 4 feet × 2 feet.

With the exception of two experimental invoices sold on the London market, which are referred to later, St. Coombs teas continued to be sold in Colombo. The average gross price for all invoices was 80.28 cents per pound as against a Colombo average for high grown teas of 79 cents. The nett average price was 75.23 cents, the cost of production being 52.39 cents.

An additional C.C.C. single action roller with electrically operated automatic pressure gear was purchased early in the year and it was decided to replace the existing Multiple green leaf sifter by a C.C.C. horizontal rotary sifter fitted with stainless steel mesh and aluminium delivery chutes. The old rollers are to have the existing brass tables replaced by kitul wood tables and battens and stainless steel boxes are to be fitted.

Staff.—No changes took place in the Senior Staff during the year. The Mycologist, Dr. Gadd, was on home leave from the 16th February to the 16th October and Mr. Lamb, Tea Technologist, went on leave on the 12th October.

In the Junior Staff, Mr. F. D. Tillekeratne was appointed Small-Holdings Advisory Officer, Southern Province, *vice* Mr. E. F. Kannangara vacated, and Mr. B. T. Schuilling was appointed as Field Assistant to the Agricultural Chemist.

Co-operation with other Research Stations.—Close contact has as usual been maintained with the Tocklai Experimental Station and with the Proefstation West Java. Mr. P. H. Carpenter, the Chief Scientific Officer, Tocklai, visited St. Coombs in April and preliminary arrangements have been made for the Chairman of the Board and the Director to pay a visit to Assam in 1939.

In last year's report stress was laid on the necessity for co-operative work between the main tea producing countries in regard to research on the chemistry of tea. Unexpected delays have hindered the organisation of this scheme, but Ceylon, North-East India, the Netherlands East Indies and South India have now all agreed to finance a joint scheme and it is hoped work will commence in a University Laboratory in England in the near future.

Advisory Work.—The volume of advisory work carried out in the past year was considerably greater than in any previous year, the number of enquiries dealt with being 3,400, a twenty-five per cent increase on the figure for 1937. Some 180 visitors came to St. Coombs and 185 visits were paid to estates by members of the staff. The latter figure would have been even greater if time could have been found.

This increase is highly satisfactory in so far as it indicates in the clearest possible way that those responsible for the working of estates are making more and more use of the Institute and finding it advantageous so to do. There can in fact be little doubt that such advisory work, bringing as it does the Staff of the Institute into personal contact with Managers, and Superintendents, has done much to disseminate a wider knowledge and better understanding of the work being carried out by the Institute. It therefore forms a most important branch of the Institute's activities and few would now deny that planting practice has been progressively influenced in this way.

The growing volume of advisory work does, however, present certain difficulties in that more and more time of certain officers is being taken up in this manner and the time for original research reduced. The problem thus raised is one which most research institutes in applied science have had to face. Where funds has permitted, a popular solution has been the appointment of special whole-time advisory officers. In the case of the Tea Research Institute it is unlikely that this will be feasible on economic grounds. The writer moreover would not favour any organisation which tended unduly to restrict the present direct contacts between research officers and estates. The results obtained in the research departments have to be applied in field and factory before benefit to the Industry can accrue, and it is essential therefore that officers should be able to familiarise themselves with practical estate working conditions and economics.

At the same time, there would be considerably less interruption in officers' time for research if a larger number of visitors could conveniently come to the Institute on visitors' day. An examination of visits made in 1938 show that only 25 per cent of such visits took place on visitors' days, the balance being spread over the whole working month. It seems evident that the allocation of one day per month as a visitors' day is insufficient and that this will have to be increased.

Experience also proves that a certain number of visits to estates were really unnecessary and equal or greater benefit would have resulted from a visit by the Superintendent concerned to St. Coombs.

Here, however, a further difficulty arises in regard to the expense of such visits by Superintendents, particularly those whose estates are at a distance. So far as arrangements at St. Coombs are concerned, facilities have been improved by the provision of a small Guest House where meals and sleeping accommodation can be obtained on reasonable terms. If Proprietors or Agency Firms would consider the payment of a small mileage allowance to members of their staffs making official visits to St. Coombs, there is little doubt the number of visitors would considerably increase.

In addition to estate visits, lectures were given to various District Planters' Associations by members of the staff. The Director also attended the meetings of the General Committee of the Planters' Association of Ceylon, the Central Board of Agriculture and occasional meetings of the Ceylon Estates Proprietary Association.

Close contact was maintained between the Institute and the above Associations as also with the Ceylon Association in London. A lecture dealing with certain aspects of the Institute's work was given to the latter body by Dr. Gadd while on home leave.

Publications—for 1938 comprised the four issues of Volume 12 of *The Tea Quarterly* and Bulletin No. 18, the Annual Report for 1397. The average number of copies issued was 1,620, of which 1,310 went to estates and proprietary interests and 236 to private subscribers. The income from subscriptions and advertisements was sufficient to leave a profit of Rs 3,063/- after meeting the cost of printing and distributing all publications.

TECHNICAL.

Pests and Diseases.—In regard to insect pests, the past year was a satisfactory one. Shot-hole borer still remains a baffling problem and so far as prevention is concerned some form of biological control seems the only conceivable method of approach. Unfortunately, however, the factors involved are such that successful control by this means seems unlikely to be achieved. Enquiries on the subject made in India and America are not in the least encouraging. Certain parasites were received from England through the courtesy of the Farnham Royal Laboratory. Very few of these however survived the vagaries of the air mail and those which did do not appear likely to be effective.

Other major pests caused on the whole little inconvenience. Few attacks of Nettle Grub were reported and, in regard to Tortrix, the position appears now to be so far improved, largely no doubt due to the

successful spreading of the *Macrocentrus* parasite, that the Institute proposes to recommend the relaxation of the regulations now in force under the Plant Protection Ordinance in connection with this pest.

Considerable trouble has been caused in the wetter areas by attacks of the green Capsid Bug *Ragmus importunitas* on *Crotalaria anagyroides*. This is of the more importance in view of the desirability of including Crotalarias in the rotation of green manure plants.

Under the head of diseases much of the time of the Mycological Division has been occupied with a further study of the new disease to which attention was first called in the Annual Report for 1936 — *Phloem necrosis*. Evidence accumulates in favour of the disease being of virus origin*. At the same time the possibility of some mineral deficiency being responsible has not escaped attention and the Institute is greatly indebted to the Imperial Chemical Industries (India) Ltd. for kindly making spectographic analysis of a number of samples.

The probability that the disease is of virus origin makes the position much more serious, since at present no cure is known for any of the virus diseases of plants. Attention must therefore be focussed on means to check the rate of spread and it will obviously be of great importance to be able to recognise the disease in its earliest stages. This is a matter of some difficulty as symptoms observed vary somewhat according to circumstances, while there is yet no criterion by which one can judge at what period after infection such symptoms first become visible. The disease has so far only been observed at elevations over 4,000 feet though it has in all probability a much wider distribution up-country than was at first suspected.

Another subject which is causing considerable anxiety is the question of Eelworm. The commonly occurring species *Heterodera marioni* has been known for a long time to attack *young* tea seedlings and certain green manures. Prior to the end of the year two estates were visited where *old* tea was found badly attacked by eelworm. The question at once arose as to whether this was *Heterodera marioni* or a different species. Specimens sent to the Imperial Bureau of Agricultural Parasitology and kindly examined by Miss Franklin were however definitely identified as *H. marioni*. In the present year, however, eelworm attacks on mature tea have been discovered on three or four other estates and in these cases the infection is due to the different species *Anguillulina pratensis* which is causing severe damage.

Should this infection become wide-spread the matter is likely to become most serious and the Institute is watching the position very carefully indeed in order to obtain the earliest information in regard to possibly infected estates. *A. pratensis* has not hitherto been reported as a pest in Ceylon though it is known in other countries as a pest of coffee.

* Since this report went to press the disease has been successfully transmitted by grafting.

It is satisfactory to note that the *Phyllosticta* leaf disease of Grevillea reported in the previous year does not appear to have extended its activities very materially and fewer attacks were reported.

Plant Physiologist.—It was mentioned in last year's report that the question of tea selection and tea propagation would form the chief future subjects of work in the Physiological Division and it is satisfactory to note that very definite progress has been made in both these subjects.

During the year many thousand picked bushes have been the subject of examination and yield records have been made of nearly 2,000 such bushes. Bushes found to be below standard are gradually eliminated and others brought into the experiment. In this way the whole of the estate will gradually be covered in the search for types of high vigour and quality.

With the co-operation of the Institute a considerable amount of similar work is also being carried out by Superintendents on their own estates with a view to selecting high-yielding plants as temporary seed-bearers.

In order that bushes found by preliminary examinations to be satisfactory in regard to yield and type may be more thoroughly tested out it will be necessary to plant up clonal plots with material vegetatively propagated from these mother bushes.

Side by side with yield tests, intensive work has, therefore, been in progress on different methods of propagation. Details will be found in the report of the Plant Physiologist and it will suffice to say here that the method found most satisfactory under Ceylon conditions is the use of single-node cuttings which are rooted in peatmoss. Careful attention to detail is necessary, but, if this be done, a very high percentage of successes can be obtained and this method of propagation may be regarded as a practical means of obtaining large supplies of clonal material.

The question of yield is not the only point of importance; quality has equally to be considered. In the Biochemical Division means have been devised for manufacturing the leaf from single bushes. The methods are naturally somewhat crude but the resulting "tea" is good enough for brokers to be able to examine and report on and such reports have been of a consistent nature in regard to particular bushes. That such tests will be of great importance in the final stages of selection is evident from the wide differences in the quality of the bushes so far examined. An interesting result in regard to one bush was the fact that the leaf was found to be deficient in the enzyme responsible for fermentation, with the result that the leaf remained bright green no matter how prolonged the period of the fermentation, and the liquor was of a pale straw colour. Addition of enzyme prepared from normal leaf, however, resulted in a normal fermentation being set up. It is obvious that a bush of the above type, no matter what its yield and vigour, would be entirely unsuitable as planting material.

Another point which will not be lost sight of is the possible occurrence of bushes showing a high resistance to disease or insect attack. It is not, perhaps, going too far to say that the future prosperity of the Industry might depend on some such discovery.

Before leaving the question of tea selection it may be noted that the provisions of the Plant Protection Ordinance with regard to the import of tea seed from India have now been modified. It is now possible for the *Institute* to import from India small quantities of tea seed for experimental purposes and advantage has been taken of this relaxation to obtain a number of "jâts" for examination.

This change in the regulations does not apply to large quantities of seed for commercial planting and estates are still prohibited for making such imports.

On the completion of the pruning experiments in progress at Galatura, the Institute's experiments on that estate were closed down. Grateful acknowledgments are due to Messrs. the Amalgamated Tea Estates Co., Ltd., to Messrs. James Finlay & Co., Ltd. and the Superintendents and Staff of Galatura Estate for the facilities placed at our disposal and the co-operation so willingly accorded.

Agricultural Chemistry.—The manurial experiments described in previous annual reports have been continued with slight modifications to permit of the effects of a higher level of nitrogen being investigated. The responses to the different treatments remain unchanged.

An interesting and important development of these experiments has been made whereby the effect of variations in the time of application of the "pruning" mixture are being studied. The earlier records indicated very clearly that an application of manure made at the time of pruning was not utilised so efficiently as later applications. The results so far obtained give strong experimental support in favour of the delayed applications, and, pending any direct evidence that may point in a contrary direction, the Institute is advising that this modification should be made in manurial practice, the "pruning" mixture being applied from three to six months after pruning according to circumstances. The actual period for which the application should be delayed will naturally vary in different cases. Thus an earlier application might be made in the case of cut-across tea on which a considerable amount of functioning leaf is left, or at low elevations where recovery from pruning is rapid, than in clean-pruned tea at higher elevations.

Admittedly some people, whose opinion is worthy of the highest respect, do not favour this advice. The Institute feels, however, that the direct *experimental* evidence in favour of the modification can no longer be ignored.

Other important investigations have been concerned with the effect of cultivation and with observations of root distribution and the effect on this of different methods of soil treatment, weeding, pruning, etc. These results are likely in due course to have an important bearing on estate practice and the results obtained to date will be a subject for discussion at the Institute's conference.

On the more theoretical side much attention has been paid to the decomposition of green manures and of tea prunings. The latter behave in an anomalous manner, probably due to the tannin content of the leaf. The presence of "saponins" which are well known to check nitrification may also be responsible for part of the effect. Though, at the moment, this work may be largely of theoretical interest, it has a practical application since soil structure and tilth are believed to be considerably influenced by the nature of the decomposition which organic matter undergoes in the soil.

Biochemistry and Manufacture.—Reference has already been made to developments which have recently taken place in regard to the organisation of joint research financed by Ceylon, India and the Netherlands East Indies on the Chemistry of Tea. The object of such work is to obtain further information as to the specific chemical constituents which give different classes of tea their characteristic properties and to correlate these analytical findings with the constituents of the fresh leaf and the changes which take place in these during manufacture.

The problem is an exceedingly complicated one, as the chemistry of the class of substances involved is still very imperfectly known. But until this can be elucidated factory research must be largely of a hit or miss variety.

Work on this subject will not however be entirely conducted out of Ceylon. Mr. Lamb and his assistant, Mr. Sreerangachar, have, in fact, already obtained very interesting results in their investigations on the chemistry of fresh leaf and of the changes which some of the substances concerned undergo during fermentation. These results are of too technical a nature to be usefully discussed here but certainly mark a definite advance in our knowledge of the subject.

The ferments or enzymes of the leaf are also being investigated by Mr. Sreerangachar.

One of the main lines of factory investigation has been the question of rolling. In particular, reference must be made to experimental work with the "Clivemeare" roller. By means of this roller very high pressure can be employed but this is applied for an exceedingly short period — the time the leaf takes to pass between two rollers revolving at a rate of about 120 revolutions per minute. The effect of this pressure is very striking, however, in that fermentation appears to be set up more or less simultaneously throughout the leaf, with the result that the infusions are very even and bright and strong coloury liquors are obtained.

In the early experiments the chief drawback was the appearance of the finished leaf which was very light and flaky. Later experiments, of which further details are given in the report of the biochemical department, made it possible to effect marked improvements in this respect and the leaf as now turned out has been favourably reported on in the London market. The Colombo market, however, which for some reason attaches more importance to appearance, still views this type of leaf with disfavour.

Eventually, two full breaks, one of normally manufactured leaf and one made using the Clivemeare roller, were manufactured and sent to London for sale. Though some difference of opinion was exhibited in the reports received, in the actual sale the "Clivemeare" invoice averaged 1d. a pound more than the normal sample, the increased price being undoubtedly due to bright and even infusions and excellent liquors.

The above invoices were made from monsoon leaf where little quality was to be expected. It will obviously be desirable to see whether the same premium is obtained in the quality season and two further comparative invoices are being prepared for sale in London. It should then be possible to express a more reliable opinion as to the value of the process.

Small-Holdings.—Advisory work in the Southern Province was resumed in the autumn when Mr. F. D. Tillekeratne, the newly appointed Advisory Officer, took up his duties at Baddegama after preliminary training at St. Coombs.

In the Kandy area a further competition amongst small-holders was organised in the Yatinuwara Palata. The final judging was carried out by Dr. Eden who reported very highly on the work carried out.

There can be little doubt that in this area a marked improvement has taken place on the condition of a large number of the holdings. Much more attention is now paid to drains, excellent terracing has been done, and gliricidias and other shade trees widely planted, while a good deal of supplying has been done. As a result a large number of small-holders who applied for re-assessment were successful in obtaining a higher quota.

Acknowledgments.—As in previous years our thanks are due to Messrs. George Steuart & Co., the Amalgamated Tea Estates Co., Ltd., the Anglo-American Direct Tea Trading Co., Messrs. James Finlay & Co., Ltd. and the Scottish Tea and Lands Co. of Ceylon Ltd., for facilities granted in connection with field experiments, and to the Superintendents of Gonakelle, Galatura, Wikiliya, Sarnia and Diyanila Kelle Estates for their co-operation in such experiments. Numerous other Superintendents have also assisted us in various directions and for this and for kind hospitality extended to members of the staff grateful acknowledgment is due.

Agency Firms and Brokers, both in London and Colombo, have also generously assisted us in numerous ways, and particularly in connection with reports on experimental teas. We must acknowledge our indebtedness to Messrs. Wilson, Smithett & Co., Messrs. George White & Co., and

Messrs. Thomson, Alston & Co., Ltd., in London and to the following Colombo Firms: Messrs. Forbes & Walker, Messrs. Harrisons & Crosfield, Ltd., Messrs. Whittall & Co., Messrs. the Colombo Commercial Co., Ltd., Messrs. Carson & Co., Ltd., Messrs. Brooke Bond (Ceylon) Ltd., Messrs. Heath & Co., Messrs. Lipton Ltd., Messrs. Somerville & Co., Messrs. George Steuart & Co., Messrs. Mackwoods Ltd., Messrs. Lee, Hedges & Co., Ltd., Messrs. Leechman & Co. and Messrs. E. John & Co.

Mr. R. H. Horne kindly acted as convener of the tasting team in Colombo, while Mr. E. Loudon-Shand has acted in a similar capacity in London. Mr. Horne also kindly reported on a large number of additional samples in his personal capacity.

The co-operation of Engineering Firms has already been referred to and we are particularly indebted to Mr. F. J. Whitehead who has freely placed his exceptional experience at our disposal. Mr. H. Tonks, the Visiting Agent, has similarly accorded valuable guidance and assistance in estate matters.

The Reports of the Scientific Staff are appended.

ROLAND V. NORRIS,
Director.

REPORT

OF

THE MYCOLOGIST

FOR 1938.

Staff.—The Mycologist was on leave from February 16th to October 17th, 1938, during which time the Plant Physiologist was in charge of this division.

Advisory.—569 letters were received and 561 despatched during the year. The corresponding figures for 1937 were 488 and 431 respectively. Consignments of diseased plants received for examination numbered 369, as compared with 294 for 1937 and 195 for 1936. These figures show an increase of 89 per cent in laboratory examinations during the last two years, which is very gratifying as they indicate a growing interest in pathological problems and in the work of this division, and not an increase of disease in the tea areas.

Of the 369 consignments 245 were tea; the remainder consisted of various plants grown as green manure or as shade trees.

41 visits to estates were made for investigational and advisory purposes in the Agrapatna, Bandarawela, Dimbula, Gampola, Hewaheta, Kandapola, Kotagala, Norwood, Nuwara Eliya and Rangalla districts.

Poria.—Work was continued in the disease plots on St. Coombs during the year. Including 7 new plots discovered during the year, there are now 136 under observation, but in only 16 of them were any diseased bushes found. In all, 71 diseased bushes were removed this year and of these 34 came from the new plots and the remainder from plots treated on the 'piecemeal' principle. Unless something unforeseen happens it is probable that this disease will be completely eradicated from St. Coombs in the next year or two.

Poria was found to attack *Crotalaria usaramoensis* and *C. anagyroides*.

Ustulina.—Dadap (*Erythrina lithosperma*) stumps rarely give rise to root disease of tea, but a case was investigated during the year which showed that dadap stumps had formed centres for *Ustulina* root disease

amongst the surrounding tea bushes. When cutting out dadaps it is advisable to sever the lateral roots and remove as much of the stumps as is possible when the trees are felled.

Rosellinia.—The root disease of tea caused by *Rosellinia arcuata* is recognised by the presence of a black fungus on the surface of the bark and mycelial stars between the cortex and the wood. A specimen of *Indigofera dosua* growing amongst tea was found to be attacked by Rosellinia. The attack had originated at the collar and the black fungus had grown downwards over the surface of the roots. No mycelial stars, however, could be found in or below the cortex and some little doubt existed whether the black fungus was indeed Rosellinia. To eliminate that doubt a piece of infected Indigofera root was placed alongside the tap root of a tea plant, about 2 years old, growing in a pot. Four months later the tea plant was dead. It was ringed at the collar in the manner frequently observed in old tea bushes, and all the symptoms, including the mycelial stars, characteristic of Rosellinia attack on tea were observed. This experiment removed any doubt that the fungus on *I. dosua* was Rosellinia.

Sooty Mould.—Comment was made in the report for 1937 of the unusual number of specimens and enquiries regarding Sooty Mould during November and December of that year. This fungus continued to be prevalent during the early months of 1938, but no injury to tea of economic importance was reported.

Excess Manure.—Branches of a tea bush were submitted for examination with a statement that several bushes were similarly affected. The branches were partly defoliated; the leaves that remained had large red-brown lesions and the ends of the branches were dying back. At first sight it appeared that an unknown leaf disease was operating, but a microscopic examination failed to confirm that suggestion. A field examination brought the following facts to notice. The affected bushes appeared to be distributed through the field in a purely haphazard fashion, and in all cases they exhibited the symptoms on one side only. The distribution, however, was not entirely haphazard as the affected bushes tended to occur in pairs but never in the same row, and the affected side of the bushes was always adjacent to a recently forked row. The trouble undoubtedly was in some way connected with the forking. The careful removal of the soil from the roots of the affected bushes soon disclosed the cause, as in every case when the surface soil was removed large masses of artificial manure were discovered.

The above is probably not a unique case. It is described here to record the symptoms associated with the improper distribution of manure and to illustrate the difficulty of diagnosing certain troubles from specimens unaccompanied by the field observations regarding occurrence, distribution and such like.

Phloem Necrosis.—Attention was first called to this disease of tea in the annual report for 1936 and a general account of it is being prepared for the conference to be held in February, the proceedings of which will be published in *The Tea Quarterly*. The information to be given there need not be repeated here.

The cause of the disease is still obscure, and as much time available for research as possible is being devoted to the elucidation of this problem. Two hypotheses are being investigated; (1) that the disease is a consequence of a deficiency or of an excess of a minor mineral element, and (2) that the cause is a virus.

An experiment was laid down to determine whether the cause was a deficiency of Boron. Diseased bushes were counted in each of the ten plots at the commencement of the experiment and again 8 months after the application of manures. Five plots were given a general estate mixture and the remaining five received the same mixture plus Boron. At the second examination there were more diseased bushes in all plots than at the first and the increase in the Boron plots was equal to that in the control plots.

When considering the question of minor elements and the possibility of a deficiency of one or other being a cause of this disease, the number requiring investigation appears rather large. The Imperial Chemical Industries (India) Ltd., by kindly making spectographic analyses of healthy and diseased material for us have very materially reduced the number which demand experimental investigation, and the Institute is much indebted to the Imperial Chemical Industries for that valuable work and report.

Greater attention is being paid to the virus hypothesis because if that should prove to be correct, *Phloem necrosis* would have to be regarded as the most serious disease of tea yet recorded. A few successful grafts have been made between diseased and healthy plants but at the time of writing no definite proof has been obtained that the disease has yet been transmitted.*

In the course of an experiment, 267 necrotic bushes were examined to determine the distribution of necrotic tissues in so far as such examinations could be made with the bushes *in situ*. Necrotic areas were found in the petioles of the leaves in 65 per cent of the bushes; in the stem in 48 per cent; and in the roots in 77 per cent. Necrotic areas were found in leaf, stem and root of the same bush in 25 per cent of the cases. Curled leaves were found on 46 per cent of the diseased bushes.

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* This has subsequently been achieved indicating that the disease is transmissible. —Ed.

The variability of the symptoms such as the presence of necrotic areas in the leaf only in some cases and in the root only in others, raises the question whether one or more diseases are concerned. For the present, however, it seems preferable to regard the disease as one which reacts somewhat differently in different varieties of tea. Recently we have come across a few cases in which the disease can be recognised from the back of the leaves, the small veins stand out prominently and are brown in colour. This symptom is not common, but it suggests that one variety is more susceptible than others. Normally the presence of necrosis in the veins cannot be seen by mere external examination of the leaf, though the characteristic curling of the leaf is indicative of its presence.

Bushes affected by *Phloem necrosis* were found on St. Coombs during the year. These are in the early stages of attack and are suggestive that the disease has arrived recently. The disease has undoubtedly been present in Dimbula for some years, but despite a lookout being kept for it on St. Coombs, it was not discovered till this year. This evidence, together with the increase in the number of infected bushes in the plots of the Boron experiment referred to above, is suggestive that the disease is on the increase.

We do not know its present distribution and until that is known with some certainty it is impossible to arrive at any definite conclusions regarding its movement if any. For the collection of such information we are dependent upon the active co-operation of estate superintendents. If on their rounds they see bushes with curled leaf, *Phloem necrosis* should be suspected and a branch sent to the laboratory for examination.

Eelworm in Tea Seedlings.—The period of development of the root knot eelworm, *Heterodera marioni,* is influenced by the nature of the host plant it invades. Godfrey and Oliveira grew cowpea and pineapple plants side by side in a greenhouse, yet under these identicial conditions the eelworm took 35 days to complete development up to the egg-laying stage in pineapple, but only 19 days in cowpea. In Ceylon, field observations indicate that *Tephrosia vogelii* is a more favourable host than tea seedlings judging from the size of the nodules and the ease with which egg-masses can be found on Tephrosia. The question arose whether the rate of development of the eelworm was slower in tea than in Tephrosia. To determine this, germinated seeds of *T. vogelii* and of tea were planted in small pots, the soil in which was known to be heavily infested with eelworm. Extruded egg-masses were found outside the galls of Tephrosia plants after 33 days but were not found on the tea roots till the 79th day.

In another experiment tea seedlings about 3 months old which had been grown in peatmoss, were transplanted into a field amongst heavily infected *T. vogelii* plants. Before transplanting the loose peatmoss was shaken off but much adhered to the root system; the root tips, however,

were visible. Root tips were examined at frequent intervals to determine whether invasion had occurred. Very few larvae could be found in the roots examined after 92 hours, but after 96 hours each root contained 5 or 6 eelworms, some partly in and partly out of the root. After 112 hours the roots examined showed 100 per cent infection with as many as 10 larvae in the root tip. At this stage the plants were replaced in peatmoss and roots were examined at frequent intervals. Eggs were first seen within the galls on the 42nd day after replanting into peatmoss. The date of extrusion of egg-masses was not determined but it is probable that it occurred earlier than was determined in the first experiment. Evidently, the life cycle of this eelworm takes longer to complete in tea seedlings than in the roots of *T. vogelii*.

Eelworm in Old Tea.—The soil of many up-country tea fields has for some time been known to be heavily infested with the root knot eelworm. This heavy infestation is very largely the result of the continuous growing of *Tephrosia vogelii* as a green manure. On a few occasions when young roots of mature tea bushes have been examined for invasion by larvae one or two have been found, but no indication of a root knot on any old root had been seen by the writer till this year, when on two estates eelworm was found to be doing severe damage to old tea. The attacked roots were stunted, thickened and somewhat distorted.

One estate submitted specimens because the Superintendents suspected eelworm attack. It is of interest that eelworm in the roots of mature tea from that estate was recorded some years ago by Mr. Petch. In the writer's opinion, after visiting the area, that attack has probably persisted during the intervening years. The other estate sent the roots because of their swollen and peculiar appearance. On that estate also the attack was of long standing. The attacked bushes were unthrifty and tended to recover late from pruning.

In order to verify our identification of the eelworm concerned, infected roots of old tea, tea seedlings, *Indigofera endecaphylla, Erythrina lithosperma* (dadap) and *Tephrosia vogelii* were sent to the Director of the Imperial Bureau of Agricultural Parasitology for identification. This Institute gratefully acknowledges his assistance, and is much indebted to Miss Mary T. Franklin for her interesting report. Miss Franklin found that the specimens submitted "are all infected with the root-knot nematode, *Heterodera marioni.*" Concerning the attack on old tea she makes interesting comments :—

> "The mature tea from the Nuwara Eliya district (Specimens 1 & 1A) contains many large females but I was surprised to find none containing eggs. In specimen 2 (roots of mature tea from Hewaheta district) very few females could be found, but there were many

lesions apparently where females had previously been located. These roots are very hard and woody, and from the number of galls and lesions the impression is gained that they have been heavily infected, but that most of the parasites have died, possibly having been unable to survive in the hard woody tissue. In roots which have been infected for some time one would expect to find nematode eggs if the parasite were finding the host congenial. The impression is gained rather, that mature tea is not a very favourable host for *H. marioni.*"

Miss Franklin's conclusion regarding mature tea being not a very favourable host for the root-knot nematode is amply supported by field evidence, otherwise it would be a wide-spread pest of up-country tea fields. The fact remains, however, that under certain conditions (not definable at present) this eelworm can establish itself on the roots of mature bushes and do considerable damage.*

Eelworm has also been found on the roots of *Centella asiatica* and *Indigofera heterophyllum.*

Grevillea Leaf Disease.—The leaf-fall disease of Grevilleas described in last year's report and in *The Tea Quarterly,* Vol. X, pp. 156-159, has now been reported from Dolosbage, Deltota, Galaha, Kegalle, Matale, Rakwana, Ukuwela and Wattegama districts in addition to those previously reported. Its distribution still follows closely that of rubber but there is no evidence that the disease originates from or is in any way connected with rubber. It seems more probable that the climatic conditions which favour rubber culture are also favourable to this disease. Also, the extent of the injury to the trees is dependent upon climatic conditions. From reports received, there appear to have been fewer defoliations in 1938 than occurred in 1937, and that fact can be attributed to the less favourable (from the parasite's point of view) climatic conditions in 1938.

During the year 39 consignments of Grevillea leaves were sent to the laboratory for examination. In only 12 of these was *Phyllosticta* sp., the cause of Grevillea leaf-fall, found. The remaining specimens were not typical of this disease but were representative of two others.

When a branch dies from any cause its leaves will ultimately fall, usually in a dry and withered condition. *Gummosis* is a common cause of the death of Grevillea branches and branches so affected were frequently sent with the dry leaves which had fallen from them. When the cause of leaf-fall is *Phyllosticta* the branches do not die previous to the leaf-fall, but normally put out new leaves in due course. Only after several defoliations do the branches die.

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* Since the preparation of this report for the Press, a different species of eelworm *Anguillulina pratensis* has been found attacking mature tea on a few estates.—Ed.

Red Spider and Scarlet Mite were frequently found associated with other specimens of fallen Grevillea leaves. Such leaves were usually older, drier and darker in colour than those affected by *Phyllosticta*. Apart from the presence of lesions or other minor characteristics, leaf-fall caused by *Phyllosticta* can generally be recognised immediately by the presence of young, fresh, fallen leaf below the affected trees. Red Spider and Scarlet Mite are known to cause defoliation of tea and it seems probable that attacks by these pests cause defoliation of Grevillea similarly.

C. H. GADD,

Mycologist.

REPORT

OF

THE ENTOMOLOGIST

FOR 1938.

Staff.—There were no changes in the staff during the year. The Entomologist proceeded on leave on April 15th, and returned to the Island on December 12th. Mr. G. D. Austin acted during his absence.

While on leave, the Entomologist attended the International Entomological Conference held in Berlin in August.

Correspondence.—839 letters were received and 932 despatched, while 293 specimens were received for report.

Visits to Estates.—45 estates were visited during the year, mainly in connection with Tortrix and the spread of its long-tailed parasite.

Tortrix.—For many years Tortrix as a pest has been on the down grade, and no severe attacks have been reported. However, it was unusual to receive news of its presence in many places in the dry zone, from Badulla, Bandarawela, Haputale, Madulsima, Halgranoya and Kandapola, between April and July. In Madulsima it continued until October.

A number of specimens of the long-tailed parasite were taken to the British Museum in 1938, and the Director of the Imperial Institute of Entomology very kindly undertook to get it described and named as soon as he could. Mr. G. E. J. Nixon was entrusted with the task, and he duly published his account in the Annals and Magazine of Natural History (II) 2 No. 9, pp. 314-319, September, 1938, naming the parasite *Macrocentrus homonae*.

During the year the parasite made excellent progress, and at the end of the year was estimated to occupy about 600 square miles of country, embracing parts of Pussellawa, Dolosbage, Maskeliya, Dikoya, and Dimbula. Two liberations were made in Madulsima, a district where in certain localities Tortrix has appeared from year to year.

A fuller account of its dispersal, and a discussion of its status as an effective check to Tortrix is to be given at the Institute's Conference in February, 1939.

Nettle Grub.—As of Tortrix, so of Nettle Grub, it may be said that in the last few years there has been a progressive decrease in area and in intensity of attack. Twelve estates reported Nettle Grub, a few only of which found it necessary to spray as a check. Spraying machines owned by various estates were freely loaned to those requiring them. The total number of machines available, including those in possession of the Institute, is 96.

In addition to the province of Uva, Nettle Grub was reported from Pussellawa (all species) Kadugannawa (*Natada nararia*) and Rattota (*N. nararia*) between August and December.

Shot-Hole Borer.—Owing to much of the previously published work on this pest being unreliable, it has been necessary to work again on the problems of life history, plant relationships and bionomics generally.

The list of alternative host-plants is somewhat impressive, and several have been tested to date, though many more remain to be done. So far, although short galleries may be driven in many different plants, no case has come to light of the beetle being able to maintain itself and raise a brood in the same way as it does on tea. It begins to appear that one is faced with a problem of races, structurally alike, that will not interbreed, and possibly also of racial differences in the "ambrosia" fungus carried.

Attention is being given to the mechanical damage caused by the beetle in relation to the types of galleries made, and the rate of growth of thickness in the tea stem.

Although biological control appears for the present to have succeeded in the case of Tortrix, a survey of the factors involved with Shot-hole borer leads one to the conclusion that similar control in the case of this beetle is extremely improbable.

Plant Bugs (*Rhyncota*).—The small green Capsid Bug, *Ragmus importunitas*, Dist. severely damaged *Crotalaria anagyroides* in June. The bug appears in large numbers from time to time, but by no means every year, in restricted localities, and can do much damage especially to seedlings. It usually appears in the wet zone about April, and dies away later. Much injury can, therefore, be avoided by planting not earlier than August. It appears to do much less damage on pruned plants.

Tea Aphis (*Toxoptera aurantii* Boyer) was reported from many places, and appeared to be far more numerous on some estates than usual. It attacks chiefly the new shoots emerging after pruning, but also sometimes the shoots of a mature bush. It is controlled by numerous natural enemies.

No reports of *Helopeltis* were received during the year.

Mites.—Red Spider (*Tetranychus bioculatus*) was several times recorded from *Grevillea*, causing defoliation. Some anxiety was felt that it might be *Phyllosticta* disease, but there was no connection whatever in all cases examined.

Scarlet Mite (*Tenuipalpus obovatus*) was also reported from *Grevillea* — sometimes associated with Red Spider, sometimes alone — and also from tea, in each case causing defoliation. Such a circumstance has not been reported for many years, and in this case is associated with colonies containing females alone. It is already established that unfertilised eggs of this mite produce only females.

White Grub.—Cockchafer larvae that go by this name have been found in compost from time to time, and in this material are dug into nurseries and supplies ending sometimes by killing a young plant.

Examination of the problem of origin shows that grubs are rarely found in compost heaps until the heaps are well broken down and more than ready for use. Occasionally, before this time, they have been found under the heap in the top of the soil. This is readily understood since, owing to the peculiar shape of the grub, it is only able to move about freely in compact soil — in a loose, immature compost heap it is not capable of moving about very much or very far.

No eggs have been found in compost so far, but it is quite possible they may be deposited in them when the heap is completely decomposed. Since beetles are on the wing and ovipositing from March to May, this is the most dangerous times for mature heaps to be lying about. To avoid oviposition heaps should be finished and distributed before March, or should not be allowed to mature before the middle of June.

Mechanical and chemical means of preventing grubs entering the compost have been tried with little success, and expenditure on this head is not considered justifiable when avoidance can be obtained, as above.

If any danger of the presence of White Grub be apprehended, it is suggested that the material should be examined visually before being put out. This should be done especially when small quantities are required, as for supplies.

Insects in Stored Tea.—From time to time, insects dead or alive, may be found when tea chests are opened in countries of destination, and in 1938 one sample of such tea submitted for report was found to contain some dead specimens of an ant (*Camponotus* sp.), and some living specimens of the beetle *Tribolium* sp.

The association of all insects connected with manufactured tea in this way is purely accidental. No insects are known to feed on made tea. The ants mentioned above sometimes frequent buildings and may be found wandering about in a factory. The beetles are pests of seeds and grains, and are always to be found in warehouses and in the holds of ships which habitually carry merchandise of this sort. They are small, flat and brown in colour and easily pass into small cracks and crannies.

C. B. REDMAN KING
Entomologist.

Planting District			1931	1932	1933	1934	1935	1936	1937	1938
Badulla	Average No. of outbreaks	per month	7.5	5.3	6.6	5.0	3.5	4.0	3.9	2.5
	Average acreage affected	,, ,,	373	439	3333	217	143	236	176	61
	Percentage (acreage) infection	,, ,,	1.14	1.33	1.00	0.65	0.43	0.71	0.53	0.19
Passara	Average No. of outbreaks	per month	7.0	4.0	4.5	7.5	9.0	4.4	4.8	2.8
	Average acreage affected	,, ,,	727	390	250	251	229	210	222	94
	Percentage (acreage) infection	,, ,,	7.42	3.98	2.54	2.55	2.32	2.13	2.30	1.00
Haputale and Haputale West	Average No. of outbreaks	per month	2.20	1.0	0.5	0.2	0.25	0.5	1.0	0.09
	Average acreage affected	,, ,,	180	46	22	0.2	75	6	11	5
	Percentage (acreage) infection	,, ,,	0.74	0.18	0.09	—	0.29	0.02	0.04	0.02
Madulsima and Lunugala	Average No. of outbreaks	per month	2.0	0.2	1.0	0.5	0.5	0.58	0.25	0.58
	Average acreage affected	,, ,,	101	1	43	5	5	24	2	2
	Percentage (acreage) infection	,, ,,	1.01	0.01	0.43	0.05	0.05	0.24	0.02	0.02
Uva	Average No. of outbreaks	per month	18.5	10.7	12.5	13.0	10.0	9.5	9.9	6.0
	Average acreage affected	,, ,,	1381	876	648	773	384	475	411	162
	Percentage (acreage) infection	,, ,,	1.77	1.12	0.81	0.98	0.49	0.60	0.52	0.22

REPORT

OF

THE PLANT PHYSIOLOGIST

FOR 1938.

Correspondence.—634 letters were received. 842 letters were despatched.

Visits.—42 visits to estates were made during the year, and five lectures were given to District Planters' Associations.

Publications.—A preliminary outline of the methods of selection and improvements of tea jâts was circulated during the year to those interested. A total of 172 copies was applied for.

Staff.—The Plant Physiologist officiated as Acting Mycologist during Dr. Gadd's absence on leave from 16th February to 16th October.

Botanical.—Questions relating to the value of individual species as cover crops are now dealt with by Dr. Eden. As in previous years a great deal of assistance in the identification of species sent in for naming was rendered by Dr. J. C. Haigh and his staff in the Herbarium of the Department of Agriculture, to whom the thanks of the Institute are due.

Polyclady.—One polycladous seedling was found in 1152 one-year-old seedlings during the course of selection experiments under conditions suggesting that the state may be due in part at least to genetic factors.

Manufacture.—The co-operation of the Biochemist is enabling tests of a small number of bushes to be used both as sources of information for selection purposes and also as a trial of the suitability of the methods of individual bush manufacture that he has evolved for use in selection of desirable mother trees.

Variability of Seedling Growth.—Four examinations of small numbers of seedlings derived from jâts that may be considered as well up to, if not above, the average of uniformity occurring in Ceylon gave the following results :—

TABLE I.

Green Weight of plants (gm).	Percentage in each size class			
	Series 1.	Series 2.	Series 3.	Series 4.
0—20	81.0	56.6	21.0	15.0
20—40	14.5	24.2	24.9	13.0
40—60	3.0	12.7	23.9	15.9
60—80	0.8	4.6	10.9	13.8
80—100	0.6	0.8	8.1	13.8
100—120	0.0	0.6	5.2	7.2
120—140	0.0	0.4*	2.9	7.2
140—160	0.2*	—	1.0	4.3
160—180	—	—	0.8	4.1
180—200	—	—	0.8	2.2
200—220	—	—	0.0	0.5
220—240	—	—	0.0	1.5
240—260	—	—	0.0	0.4
260—280	—	—	0.3*	0.4
340—360	—	—	0.3*	0.5*
360—380	—	—	—	—
Age (months)	15	15	24	24
Total No. of plants examined	649	503	385	414
Mean weight of all (gm.)	15.3	24.4	52.2	78.6

Those plants occupying an exceptional position in the yield distribution which are denoted by an asterisk were chosen on account of their exceptionally good growth for propagation and further examination. Several further plots of seedlings have been established for selection purposes.

In addition to providing an example of seedling selection the data indicate firstly, the large predominance of relatively small plants in nurseries and, secondly, the fact that as the average weight increases according to age or soil conditions a slight spread of a small number of plants into classes of greater weight than the average tends to occur. For example, in series 1, having an average weight of 15.3 gm. 19.1 per cent. occur in classes above that containing the average weight. In series 4, this has

risen to 42.1 per cent. This points to the presence in young beds of seedlings which are small through some external check to their early establishment which later make good growth and show their real vigour. This emphasises the value of delaying selection as long as possible.

In passing it may be noted that the weights of the plants selected for clonal propagation were approximately 10, 5, 5, 7, and 4 times as great as the average weights of the respective series.

The practical application of these data in nursery selection has been the subject of considerable interest during the year and it may be noted that the Experimental and Estate Sub-Committee has resolved that no planting be done on St. Coombs save with plants that have undergone selection for vigour in the nurseries.

Variability of Tea Yields.—Experiments have been laid down to determine the variability of yields, firstly from bushes of Clone T9 and from existing "low medium hybrid" tea, and secondly from bushes of Clone T9 and seedlings selected by eye for uniformity at 6 months of age. This will allow of a preliminary estimate of the relative importance of variation in environment from bush site to bush site and of variation due to differences in the inherited genetic constitution.

It was found, during preliminary selection work, that the yield from the 50 per cent. best bushes amounted to from 60 per cent. to 80 per cent. of the total crop, and that 10 per cent. of the worst bushes (say 350 per acre) could be removed with a yield loss of between 3½ per cent. and 6½ per cent. The removal of 5 per cent. of the worst bushes is likely to reduce yield only by from 1 per cent. to 2½ per cent. It may be noted that the area from which these data were secured were "even" and did not contain poor areas.

Considerable variation in the relation between the diameter of bushes cut across 6 ins. above the last pruning cut and the weight of prunings removed was found to occur, due to the variation in the amount of growth remaining below this level of pruning owing to differences in growth habit between bush to bush. The use of these criteria for preliminary selection of bushes for yield recording was therefore abandoned.

Selection.—Selection of high yielding bushes for subsequent test of the clones produced from them by vegetative propagation in respect of both yield and the characters of the made tea, in conjunction with equally important lines of investigation upon methods of vegetative propagation, became during 1938 the main work of the department, and while results are obviously not to be expected in a short time, it may be said that indications are not lacking that valuable results may be achieved from this work. On St. Coombs selection of bushes is now a routine process in every field as it is pruned; originally "promising" bushes which under test give disappointing results are discarded by a regular system, thereby permitting the continuous extension of the work to fresh sets of bushes, which are selected by eye for apparent vigour at the time of pruning.

During the year many thousand picked bushes have been the subject of experimentation for varying lengths of time. Approximately 2,000 have been made the subject of yield records.

It is hoped to continue to maintain a total between 800 and 1,200 bushes under examination simultaneously for the next three years. The actual bushes are constantly changing, so that a very considerable number of bushes will undergo detailed examination, while each bush over the whole estate, save those in experimental areas, will undergo some form of selection. It is hoped that between five and ten years hence a number of forms worthy of extended test in different planting districts may emerge.

While this work is naturally being done on St. Coombs on a larger scale than would be possible on other estates, a number of estates are now conducting yield trials on lines suggested by the Institute with a view to selecting high-yielding plants for use as bearers. In addition, numerous attempts are being made to ensure greater uniformity in the progeny of existing bearers, and a considerable improvement in the visual uniformity is likely to result, but of course such work can only be regarded as a temporary palliative for existing conditions, pending the production of bearers selected by better methods than visual observation. It cannot be too strongly stressed that the improvement of a crop is a progressive process and that any sound seed-bearer programme must be based upon progressive replacement of bearers in the future as new and improved types become available. The slow and tedious nature of the work must be regarded as an additional reason for proceeding with it at once, and not as a reason for postponing it indefinitely.

The willing aid of numerous estates and equally numerous superintendents in furthering the Institute's selection work by the supply of information and material is recorded with gratitude.

Propagation.—1. *Budding.*—Work upon this method of vegetative propagation has been somewhat overshadowed by methods involving the use of cuttings. Early in the year, however, an experiment was started to determine the best weather and seasonal conditions for budding. The data will not be complete until the latter half of 1939, and it is therefore too early to draw conclusions. It may be noted, however, that the percentage of successes obtained remains disappointingly low. Nevertheless the method holds undoubted possibilities for use in establishing seed-bearers from selected high-yielding bushes, and is being investigated with that end in view. The growth made by a scion budded onto a vigorous stock is naturally much more rapid than that of a cutting.

2. *Cuttings.*—The trend of investigations upon this method of vegetative propagation has been considerably influenced by the particular suitability of peatmoss (of the grade termed "Medium" by the importers) for use as a rooting medium. For example, in grit less than 1 per cent. of the cuttings of T3 rooted in the course of 7½ months. In peatmoss 77 per cent. were found to have rooted in 3¼ months.

The type of cutting employed consists of a leaf and the stem beneath it down to a point a little above the junction of the next leaf below with the stem. If a suitable stem is cut just above each leaf with a *sharp* knife such cuttings are readily obtained. The cut should not be very oblique. Very young leaves are undesirable as they wilt and rot; old leaves tend to drop off either during propagation or too early after planting out in the field. The maintenance of an adequate leaf surface is of importance and it is therefore very desirable to pay attention to this point. Fully mature leaves on green or *lightly* reddened stems are the best, and it is no disadvantage if the bud on the axil of the leaf has started to grow a little. If much growth has been produced, however, the tender shoot should be pinched back to the first fish leaf from the stem before planting.

The peatmoss is lightly beaten to break up lumps and moistened for several days prior to planting, so that it is thoroughly moist but not sodden. About six inches is a suitable depth in a box or bed; if in a box, the cuttings may be covered with advantage by a sheet of glass. In any case arrangements should be made to prevent direct sunlight or even bright light reaching the cuttings. It is for this reason that the back of an airy verandah or similar structure is suitable. The cuttings should be lightly moistened down every evening, or more frequently in very dry weather, *but the peatmoss must not be rendered sodden.*

The best time of the year in the south-west zone is just before the break of the South-West Monsoon. By its end the cuttings will have developed young roots and may be gradually hardened off prior to planting in the North-East Monsoon. Five to six months should be allowed for rooting and hardening off, when the plants can be lifted with a ball of peatmoss attached and planted either in baskets or bamboo pots in a nursery for the production of stumps, or direct into a prepared plot. If the latter step is taken, the services of an experienced garden cooly are necessary in the early stages of establishment to prevent sun scorch etc., as unless care is taken considerable loss may occur from this cause. The use of a heavy shade of cut grevillea foliage thinned daily after the first fortnight obviates this. With rather less satisfactory results, cuttings may be rooted under shades of hessian or manna grass supported on wire netting.

Once established, cuttings appear to grow equally as well as seedlings of the same age, but different clones exhibit very marked differences in ease and speed of rooting. These differences reach their full expression when sand is used as a rooting medium, but are less obvious, though still marked, when peatmoss is used.

Several experiments have been carried out upon propagation by cuttings during the year in addition to routine propagation of selected bushes. In the annual report for 1937 it was noted that peatmoss was apparently proving distinctly more satisfactory than sand, and an experiment was therefore set up to compare the rooting of seven clones in sand and in peatmoss both in the presence of and absence of phenylacetic acid in solid form exposed within the propagation box.

A total of 1,020 cuttings was used.

The sand was a coarse white silica grit obtained from decomposed quartzite in the Madulsima district.

The mean results after six months were as follows:—

TABLE II.

	Peatmoss	Grit	Ph. Acid.	Nil
Percentage alive	88.9	81.8	83.8	86.8
Percentage rooted	86.8	51.5	67.3	71.0
Percentage of survivors rooted	97.6	61.0	77.8	80.8

The presence of phenylacetic acid in the boxes had no effect and the tentative conclusions mentioned in the annual report for 1937 must, therefore, be abandoned. Peatmoss as compared to sand did not affect the percentage of cuttings alive after six months, but did significantly increase the percentage of cuttings rooting in that period, whether expressed on the basis of the number of original cuttings or of the number surviving alive. The differences were not confined to numbers rooting — the larger and more vigorous root systems formed in peatmoss were particularly noteworthy. Measurements were not made, however, as the clonal material was required for planting out.

In addition to the main effects an interesting interaction was found. The difference between the percentage of original cuttings (and also the percentage of surviving cuttings) which rooted in peatmoss and in sand varied according to the clone, the difference being the greater the poorer the rooting of that particular clone in sand. The explanation of this would appear to be unlikely to be linked with water supply, for the percentage of cuttings surviving six months do not differ significantly. The acidity of the medium or the presence of growth-controlling substances may affect rooting. The peatmoss used is a more acid medium than sand, and the healthy condition of the roots of the cuttings which rooted in sand indicates that the acidity factor, while probably having some effect, cannot be regarded as the sole cause of the differences observed. Until specific tests are made, the presence of any chemical compounds in peatmoss affecting the production of roots from stem tissues must remain uncertain, but there would appear to be grounds for postulating their presence.

Clonal differences in the amount of roots formed and in the percentage of cuttings rooting were most marked, as is shown in the following figures of the percentage of cuttings rooting :—

TABLE III.

Clone	T13	T14	T15	T16	T17	T18	T19
Sand	35.7	19.5	71.0	53.7	72.5	58.4	50.0
Peatmoss	64.3	81.7	88.7	93.9	94.9	95.0	89.1

It will be noted that the effect of the use of peatmos is to reduce these differences but not to mask them entirely.

A further experiment was carried out to determine the effect of dropping the cuttings as made into 2.0 per cent dextrose plus 0.1 per cent. urea in water and leaving them immersed overnight (17 hours) as compared to similar treatment with tapwater. Total immersion was tested, although not desirable from some points of view, as being more convenient for large-scale propagation work than immersing only the short stem of the cutting. As a whole the results showed no significant effect upon the number of cuttings surviving or the number rooting in a period of 18 weeks. When the clones were considered separately, however, it was found that on the basis of the original number of cuttings, the rooting of T26 had been increased significantly from 75 per cent. to 86 per cent. whereas the rooting of T9 was unaffected. The figures were :—

	% Surviving		% Rooted		% of Survivors Rooted	
	Treatment	Control	Treatment	Control	Treatment	Control
T26	93.4	81.4	86.2	74.8	92.3	91.9
T9	88.4	93.8	75.4	76.0	85.3	81.0

The percentage of survivors rooting was, however, not significantly affected and it thus appears that the effect on T26 was due to the larger percentage surviving when treated with sugar and urea, and that no specific effect on rooting occurred. The difference between T26 and T9 in this respect may be partly a question of clonal differences, but further experience has suggested that this is not the complete story. Difficulty has always been found in propagating cuttings in which the leaf is incompletely developed as for example when cuttings from young tipping shoots are used; insufficient carbohydrate supply was suspected as the cause of the difficulty. In this case the leaves used from T9 were fully developed, while those of T26 were of tipping character, the parent bush having been pruned

TABLE IV.

No. of cuttings treated	Chemical	Strength	Hours	% Alive	% Alive Control	% Orginal leaf present	% Original leaf present control	% Root-ed	% Rooted Control	% New Shoot growth	% New Shoot growth control	Dry Wt. roots per 100 gm.	Dry Wt. roots per 100 gm. control.	Dry Wt. new leaf & stem per 100 gm.	Dry Wt. new leaf & stem per 100gm control.	
100	Seradix A	1/114	20	89	94	87	94	78	87	73	83	3.08	2.62	4.92	5.03	
100	Planted fresh	—	—	93	94	91	94	87	87	78	83	4.05	2.62	5.42	5.03	
160	Seradix A	1/114	20	87	86	87	86	82	76	53	59	9.24	5.20	2.81	2.53	
20	Beta indolyla-cetic acid	1/2500	18½	70	90	70	90	70	90	25	73	10.25	8.23	2.20	3.15	*
30	do	1/5000	18½	70	88	70	88	70	85	63	68	4.56	8.50	2.90	2.58	*
30	do	1/7500	18½	67	88	67	88	57	85	30	68	8.72	8.50	1.83	2.58	*
180	do	1/10000	20	63	91	83	90	82	87	75	77	7.09	8.59	4.33	3.52	
200	do	1/12500	20	85	90	85	89	83	85	70	85	6.66	6.42	4.56	6.83	
200	do	1/15000	20	85	90	85	88	77	76	78	81	3.23	2.64	5.24	5.97	
200	do	1/17500	20	81	75	81	74	74	67	67	63	6 43	5.66	3.94	4.53	
200	do	1/20000	20	89	90	89	90	80	82	74	79	4.44	4.86	3.82	4.73	
200	do	1/22500	20	87	87	87	87	82	83	80	75	8 57	6.40	6.20	5.41	
220	do	1/25000	20	95	95	95	95	90	81	89	86	4.82	4.61	5.96	5.57	

*Statistical analysis not performed owing to small number of samples.

═══ Significant difference in favour of controls.

——— Significant difference in favour of treatment.

some 3½ months before, and it is possible that the extra supply of carbohydrates provided by the dextrose solution may have enabled development of the leaves to be completed normally. This will be further tested to determine whether it is possible to obtain a method of producing more successful results from "tipping" type cuttings.

Tincker (Journal of Royal Horticultural Society, 1938, LXIII, 218) has reported that 1/10,000 beta indolylacetic acid induced better rooting of cuttings of *Camellia japonica*, and *Schima argentea*, both being relatives of tea. At a conference on the use of chemical substances of this type in horticulture held at the Royal Botanic Gardens, Kew, in 1937, it was reported that certain similar treatments of Camellia spp. had failed to cause better rooting and it was therefore considered very desirable to settle this point in the case of tea.

Accordingly an experiment was started in which the cuttings were placed out of doors under a hessian shade in June, the effects of a proprietary preparation and various concentrations of beta indolylacetic acid being compared to a similar treatment with plain water. A trial of planting immediately after cutting without water treatment was also included. The results shown in Table IV suggest that a considerably greater dilution is required for *Camellia sinensis* when the cuttings are inserted in peatmoss if the possibility of harmful results is to be avoided.

There appears to be a gradual transition from unfavourable to favourable effects upon the percentage of cuttings rooting, but up to the limit explored the results did not compare in magnitude with the differences between the rooting capacity of different clones. Sufficiently satisfactory results are obtainable in peatmoss to obviate the need for preliminary treatment with special chemicals so far as present results go. The question whether the greater dilution apparently required is due to the presence of substances already in the peat, or is a peculiarity of tea, remains undecided.

The pencentage of the cuttings rooting in a given period must be distinguished from the time elapsing before roots are produced upon which data are lacking. The weight of roots produced in so long a time does not necessarily agree with the percentage rooting, and indications appear that an effect on the gross weight of roots produced may occur, *e.g.*, the second experiment on Seradix A.

Pre-treatment of cuttings with growth controlling substances will not, however, be adopted here as a routine measure in propagation until more evidence is obtained of its real value under the conditions of propagation in use.

3. *Root Cuttings.*—Attempts to strike small portions of roots in sand having failed, an experiment has been commenced to determine the usefulness of enforcing the production of numerous rootgrowths (which may later be transplanted) by removing the main portion of the central root and leaving the thick ends of the severed roots exposed to light and air.

4. *Seedling Grafts.*—It has been found possible to graft onto the radicles of freshly germinated seeds. The plumule is pinched back after union of the scion, leaving the nourishment in the cotyledons available for production of new growth by the scion. When exhausted the cotyledons are removed by trimming the stock root back to just above the point of union with the scion.

5. *Wire Ringing.*—The twisting of thin wire round the bases of young shoots followed by earthing over to the depth of about a foot has resulted in the production of prolific roots.

6. *Incompatibility.*—Experiments to determine the extent of the occurrence of incompatibility between stock and scion have been commenced and will be extended.

7. *General.*—The Imperial Bureau of Fruit Production, from which the Institute has received a great deal of willing help, requested the aid of the Institute in the preparation of a synopsis of vegetative methods of propagating tea, which was gladly given.

Seed-Bearers.—Knowledge concerning the behaviour of seed-bearers, either in districts receiving two monsoons or in those receiving one, is very scanty. The only data available are usually the quantities of seed collected for sale or home use, which are of very little real value.

Records have been kept weekly from the 1st January, 1938, of the numbers of flower buds, open flowers, fruits of all sizes and ripe fruits found split upon the tree on three young seed-bearers. While more data are still needed the following tentative conclusions may be of value to estates receiving both monsoons :—

The seed-bearers may be described as follows : A—very low jât "China." B—Good medium jât. C—Poor medium jât.

Flowering.—It will be observed that marked differences occurred between the three trees in the course of the year in the production of flower buds. In the case of bearers B and C the numbers rose more and more rapidly to a maxima around the twenty-eighth week, soon after which a rapid fall set in, the numbers remaining low between the thirty-sixth and fiftieth weeks, when there was an extremely sharp rise due to the production of inflorescences in the axils of the leaves on the shoots produced earlier in the year. In contrast to this, flower buds on bearer A tended to increase steadily in number throughout the year, the rise at the fiftieth week being distinctly less marked. With this was associated a difference in the occurrence of open flowers. On bearer B the flower maximum was sharply defined at the thirty-second week. The maximum for bearer C occurred at the same time but was much less sharply defined, while in the case of bearer A only indications of a minor peak about this time were observed, a well defined maximum occurring at the forty-sixth week, when relatively very few open flowers were observed on bearers B and C. While

TABLE V

Week	A.				B.				C.			
	Flower Buds	Flowers	Unripe Fruit	Split Fruit	Flower Buds	Flowers	Unripe Fruit	Split Fruit	Flower Buds	Flowers	Unripe Fruit	Split Fruit
1	87	0	384	2	990	4	61	1	320	1	198	0
2	88	2	353	3	888	3	62	0	305	5	208	0
3	92	1	343	2	928	6	75	0	306	2	198	0
4	105	2	342	3	1036	4	75	0	317	6	194	0
5	111	3	334	2	1078	3	50	0	354	5	179	0
6	112	0	334	3	1170	9	57	0	387	5	178	0
7	110	2	339	4	1253	9	74	2	450	9	173	1
8	97	1	336	0	1381	10	115	1	526	3	192	2
9	89	1	330	2	1377	13	110	1	568	6	178	1
10	82	1	315	1	1430	28	121	0	597	9	165	1
11	81	2	306	3	1381	11	150	0	644	5	160	0
12	84	1	282	2	1378	12	149	0	648	6	161	0
13	89	3	271	9	1447	13	147	1	713	0	148	1
14	105	0	225	9	1525	22	133	1	727	0	139	3
15	114	2	197	6	1729	8	123	2	830	8	126	2
16	115	2	167	17	1718	17	101	9	811	11	133	5
17	151	2	136	4	1664	9	146	2	901	11	133	2
18	159	1	122	1	1766	16	135	0	936	19	140	0
19	206	3	99	2	2055	20	186	0	1033	31	262	5
20	260	1	80	1	2472	23	186	0	1087	24	173	2
21	303	0	78	2	2536	39	263	0	1280	13	118	4
22	336	0	75	3	2839	6	363	0	1347	14	210	1
23	374	0	73	2	3681	23	297	0	1359	23	216	2
24	382	2	80	1	3807	19	334	0	1698	10	205	0
25	409	5	93	0	4256	32	409	0	1748	19	216	1
26	369	6	95	1	3863	27	374	0	1618	19	254	0

TABLE V—*Contd.*

Week	A.				B.				C.			
	Flower Buds	Flowers	Unripe Fruit	Split Fruit	Flower Buds	Flowers	Unripe Fruit	Split Fruit	Flower Buds	Flowers	Unripe Fruit	Split Fruit
27	372	4	124	1	3981	15	389	0	1725	14	269	0
28	398	0	135	0	4064	30	424	0	1811	21	250	0
29	427	1	134	0	4237	19	487	0	1948	24	294	0
30	409	12	184	0	2817	41	422	2	1640	35	345	0
31	400	6	253	0	2615	32	453	0	1695	22	355	0
32	449	5	258	0	1734	101	635	0	1234	42	491	0
33	498	10	281	0	1480	84	671	0	974	40	539	0
34	629	5	257	0	1267	52	617	0	879	32	595	0
35	658	4	304	0	1095	25	540	1	838	33	595	0
36	749	2	283	0	433	7	352	0	520	14	661	0
37	763	1	269	0	313	2	271	0	411	11	714	0
38	779	4	301	0	274	2	98	0	295	9	581	0
39	795	7	315	0	259	1	100	0	288	3	733	0
40	800	10	311	0	247	4	111	0	310	9	697	0
41	842	8	304	6	70	0	70	0	266	2	383	0
42	870	10	329	0	64	0	51	0	325	4	504	0
43	893	9	343	0	65	0	49	0	334	8	511	0
44	857	15	367	2	203	0	90	0	424	3	293	1
45	859	12	383	1	201	1	77	0	358	3	298	0
46	744	39	374	2	199	4	68	0	315	9	304	0
47	677	21	410	2	455	3	75	0	322	3	347	0
48	709	8	394	0	469	2	78	0	329	5	326	0
49	812	12	484	1	606	6	123	0	336	3	378	0
50	843	9	519	0	643	3	139	0	343	0	310	0
51	1035	9	510	0	2294	0	153	0	1283	3	646	0
52	1242	8	567	0	2444	2	168	0	1583	5	743	0

weekly observations are less valuable than daily ones, there is evidence of distinct differences in reproductive periodicity between the separate bearers, which may be connected with the observation that while the leaders on bearers B and C were growing actively from the 20th week onwards the leaders on bearer A remained dormant between the 20th and 40th weeks. To what extent these differences reflect differences in jât must at present remain open, but it is obviously desirable to collect further data on the subject.

Fruiting.—The numbers of unripe fruits upon the bearers are also varied in the same order as the "jât," namely A.B.C. On bearer A numbers fell steadily to the twenty-third week and thereafter rose throughout the year. On bearer C the numbers fell to a minimum at the twenty-first week thereafter rising to a maximum around the thirty-ninth week, falling sharply and rising equally sharply in the last two weeks of the year. In contrast to this bearer B had more and more unripe fruit until the thirty-third week, when a sharp fall to the original level set in followed by a slow rise during the last month of the year.

The maximum for split fruits is more uniform though the same gradation A to C to B is observable, the first producing fruit over the longest period. The maximum for all three is in the sixteenth week.

It is of interest to note that neither the numbers of flower-buds, and flowers, nor the numbers of unripe fruits and split fruits appear to be closely linked and there is in fact evidence of very considerable wastage.

It is hoped that those interested in seed-bearers will collect data throughout the year of the number and weight of seed obtained by regular collection from say, twenty-five bearers. Such data would be of assistance to the Institute if asked to advise upon the bearers.

Polyploidy.—Experiments in the production of polyploidy in seed-bearers by means of gamma rays and of colchicine are in progress, with a view to later selection among the progeny.

Plucking Data.—A subject upon which, in the nature of things, considerable variation of opinion occurs, is the correct length of plucking round. An extensive comparison between rounds of 7 days and of 14 days under the same conditions indicated no reason to suppose that there was any real advantage from a manufacturing point of view in a long round. The long round resulted in considerable loss of crop but under estate conditions this would be compensated for to a slight extent by a reduced cost of plucking. The reduction in plucking costs resulting from a long round is not, however, as large as might be expected owing to the larger amount of breaking back to be done and hard banjie to be removed. As was pointed out when these results were reported, it is necessary for every estate to balance out these two partly conflicting advantages of yield and low plucking costs, but it may now be pointed out that plucking rounds under conditions similar to St. Coombs should not normally exceed nine days. The following data collected during the year substantiate this.

TABLE VI.

FIRST OBSERVATION.

Experiment	Average (Days)	PERCENTAGE OF SHOOTS TAKING FROM TWO TO FOURTEEN DAYS TO PRODUCE A NEW LEAF												
		2	3	4	5	6	7	8	9	10	11	12	13	14
1	6.5	—	1.0	6.3	15.6	26.0	30.2	14.6	5.7	0.5	—	—	—	—
2	5.1	—	4.1	27.3	39.7	17.5	7.7	2.1	1.0	0.5	—	—	—	—
3	7.5	—	—	—	5.1	22.8	22.8	21.5	21.5	5.1	1.3	—	—	—
4	6.6	—	—	7.1	19.2	33.3	13.1	11.1	9.1	4.0	3.0	—	—	—
5	7.0	—	—	5.4	18.5	23.9	17.4	12.0	14.1	3.3	2.2	2.2	—	1.1
6	5.8	—	2.1	9.3	26.8	33.0	23.7	4.1	1.0	—	—	—	—	—
7	6.7	—	—	3.3	14.4	21.1	43.3	11.1	4.4	1.1	0.0	1.1	—	—
8	6.5	—	1.2	6.0	12.0	27.7	38.6	9.6	3.6	1.2	—	—	—	—
9	5.6	1.1	3.2	19.4	24.7	20.4	23.7	5.4	2.2	—	—	—	—	—
10	5.7	1.1	1.1	14.7	29.5	32.6	12.6	4.2	4.2	—	—	—	—	—
11	6.7	—	2.0	7.1	12.2	25.5	20.4	21.4	7.1	2.0	1.0	1.0	—	—
Average	6.34	0.20	1.34	9.63	19.79	25.80	23.05	10.65	6.72	1.61	0.68	0.39	00	0.1

TABLE VII.

SECOND OBSERVATION

Experiment	Average (Days))	PERCENTAGE OF SHOOTS TAKING FROM TWO TO FOURTEEN DAYS TO PRODUCE A NEW LEAF												
		2	3	4	5	6	7	8	9	10	11	12	13	14
1	8.1	—	—	1.6	2.2	10.2	20.4	26.3	24.2	9.7	3.2	1.6	0.5	—
2	5.1	1.0	7.7	26.8	34.0	19.6	6.7	0.5	2.1	1.0	0.5	—	—	—
3	7.5	—	—	—	9.1	19.5	22.1	22.1	16.9	7.8	1.3	—	1.3	—
4	7.8	—	—	—	4.0	13.1	32.3	17.2	21.2	9.1	3.0	—	—	—
5	7.5	—	—	2.2	4.4	22.0	27.5	22.0	11.0	4.4	3.3	2.2	—	1.1
6	6.4	—	—	4.2	21.9	27.1	27.1	16.7	3.1	—	—	—	—	—
7	6.8	—	1.1	6.7	11.1	23.3	30.0	17.8	2 2	5.6	—	2.2	—	—
8	6.6	—	—	1.2	22.9	25.3	28.9	13.3	3.6	4.8	—	—	—	—
	7.1	—	—	1.1	6.5	31.2	24.7	22.6	8.6	5.4	—	—	—	—
10	7.4	—	—	1.1	4.2	19.8	26.0	30.2	13.5	4.2	1.1	—	—	—
11	7.5	—	—	1.0	6 1	17.3	37.8	18.4	8.2	3.1	4.1	2.0	1.0	1.0
Average	7.07	0.09	0.80	4.17	11.49	20.76	25.77	18.83	10.42	5.01	1.50	0.73	0.25	0.19

TABLE VIII

Percentage of shoots producing an additional leaf in seven days and in nine days.

Experiment	Month	Field	Age from pruning in days	First leaf opening 7 days	First leaf opening 9 days.	Second leaf opening 7 days	Second leaf opening 9 days.
1	March	8	138	79.1	99.4	34.4	84.9
2	May	6	233	96.3	99.4	95.8	98.4
3	June	9	810	50.7	93.7	50.7	89.7
4	June	8	228	72.7	92.9	49.4	87.8
5	June	6	263	65.2	91.3	56.1	89.1
6	September	7	261	94.9	100.0	80.3	100.0
7	September	8	311	82.1	97.6	72.2	92.2
8	September	9	888	85.5	98.7	78.3	95.2
9	November	9	965	92.5	100.0	63.5	94.7
10	November	8	384	91.6	100.0	51.1	94.8
11	November	7	335	67.2	95.7	62.2	88.8

In each experiment from 100 to 200 shoots, four shoots per bush, were labelled and the date of unfolding of one, two and three leaves recorded exactly. From these data the number of days required for each shoot to produce one extra leaf, and a second extra leaf, can be easily calculated. Different shoots unfold leaves at varying rates, from two days to fourteen. The percentage of shoots unfolding leaves at these different rates are shown in Tables V, VI and VII. Comparing first the average rates of unfolding in Tables VI and VII, it is apparent that while there is a slower unfolding of the second leaf in comparison to the first the difference is significant. The age of the bushes from pruning (see Table VII, VIII) had no effect upon the rate of development of the shoots. The age from pruning while affecting the pecentage of shoots going banji, and the size of the shoots produced, does not affect the developmental rate of actively growing shoots. The practice of plucking old fields on a longer round once more appears theoretically indefensible and it is suggested that the economic basis of the practice is worthy of careful scrutiny since a longer round is likely to result in a reduction of the most valuable portion of the estate's crop.

It is noteworthy that no consistent sign of a seasonal effect upon the rate of unfolding was observed. The effect of a "rush" would therefore appear to be mainly confined, as previous observations have suggested, to an increase in the number of shoots rather than in their rate of unfolding. Environmental conditions are certain to have some effects on the rate of unfolding, but that consideration is besides the point from a practical point of view if such effects are in general minor.

The results of these experiments thus confirm the practical view that *constancy* of rounds is of the greatest importance and that care should be taken to see that rounds are not longer than economically *necessary.*

"Flush waving in the breeze" would appear to be due more to large numbers of shoots emphasising the effects of delays due to the large quantity of flush to be harvested rather than to effects on the rate of development of individual shoots. The phrase "This weather will bring the flush on" would appear to be properly interpreted as indicating a trigger effect of climatic conditions on the *number* of shoots developing rather than an effect on individual shoots. The practice of plucking rather harder at the beginning of a rush is in no way affected by these results, its effect being to remove a proportion of shoots at an earlier stage of development than normal, before the crop has reached its maximum, and so to reduce the strain on the plucking capacity of the estate when this occurs.

The length of plucking round is of course a compromise since continuous plucking would enable each individual shoot to be removed as it reached the required standard of development and would, therefore, be ideal. Such a procedure can never be economic or feasible, but it should be realised that the length of plucking round decided upon should be as accurate a compromise as possible between loss of labour due to having to cover too great an area per day, and loss of crop due to overgrowth and hardening of soft banji, etc.

In any field just plucked there will be shoots of three leaves and a bud not sufficiently developed to have been plucked, shoots of two leaves and a bud which will become three leaves and a bud in from one day to a maximum of thirteen days, and shoots of one leaf and a bud which will become two leaves and a bud in one to thirteen days.

Taking these classes separately and using the average rates from Tables VI and VII we have: Shoots of three leaves and a bud too small for plucking will become four and a bud in seven days on the average; shoots of two leaves and a bud will become three and a bud in six days on the average, but those developing quickly may become four and a bud; shoots of one leaf and a bud which become two leaves and a bud the next day will, six days after that, be three and a bud.

Thus in seven days a fair proportion of the shoots will be ready for plucking. However, on any system of periodic plucking it is obviously desirable to ensure that the majority of three leaves and a bud, too small for plucking at one round, are removed at the next. Table VII indicates that at nine days this is very fully realised and this length is therefore recommended under conditions similar to St. Coombs. It may be noted that this time has been the standard round on experimental plots on St. Coombs since experiments were started there and experience of these experiments has fully confirmed the considered opinion of the Experimental Committee given in 1930, based on general experience in the district, that a nine-day round would in general be the most suitable.

The practical advantages of a short round where a long cycle is in practice will be obvious, since breaking back is so largely obviated. In fact, it may be said that the shorter the round the less time will be wasted in dealing with leaf which will not be manufactured. Against this must be offset the time lost in moving from bush to bush over a larger area per day.

Improvement of Old Tea.—An experiment upon six methods of dealing with old tea was started on March 23rd, 1937, on 60 plots of originally 120 bushes per plot arranged in 10 blocks.

The following are the six treatments:—

1. Normal pruning (Control).
2. Normal pruning interplanted with one new plant between each two bushes *in* the rows.
3. Collar pruning of existing bushes.
4. Collar pruning and interplanting as 2.
5. Removal of existing bushes and replanting at the same spacing as before ($3\frac{1}{2}$ feet).
6. Removal of existing bushes and replanting at the old distance between the rows, but half the old distance in the rows.

It will be noted that in each of the three pairs of main treatments one is not interplanted and the other is.

Number of old bushes uprooted 2,346. Average per cooly 30.9 bushes.

Number of old bushes collar-pruned 2,271. Average per cooly 36.6 bushes.

Number of old bushes clean-pruned 2,289. Average per cooly 151.9 bushes.

(These figures cover the whole of the work; at the end 35 bushes per cooly were being uprooted. Where the tea bushes are small this number can be considerably exceeded).

Number of collar pruned bushes recorded as dead on the 13th May, 1938=21=0.92%. (All collar pruned bushes which showed signs of reviving were left).

Number of holes 5,672. Average per cooly 64.6 holes per day. Number of holes filled per cooly per day 284.1. Stumps were planted on 5th and 6th August, 1937 and were dipped in cowdung before being planted. Number of stumps planted per cooly 161.1 per day. Number of plants dead on 14.5.38, 856. (15.1%). Tarring of collar-pruned bushes average per cooly 283.9 per day.

The following manure is applied every six months:—

Nitrogen	...	20 lbs. per acre.
Phosphoric acid	...	15 lbs. per acre.
Potash	...	10 lbs. per acre.

All plots are planted with cover crop. This is controlled every month.

Collar-pruned bushes were tipped at 18 ins. from pruning level on 21st May, 1938.

There are already indications that interesting results on competition will be obtained, but they will not be reported until records are available over a longer period than at present.

An experiment to determine the advantages of holing, trenching or plain forking after uprooting old tea as a preparation for the planting of new material has been started.

Dieback at Higher Elevations.—The results of a further experiment upon lung-pruning at Sarnia Estate, Badulla, were obtained during the year. The first experiment is reported in the annual report for 1937, it being then found that after pruning in November, no significant difference in the amount of dieback after pruning occurred between lung-pruned and clean-pruned plots. July pruning in 1937 was, however, found in April 1938 to have resulted in distinctly more dieback on the clean-pruned plots than on the lung-pruned plots, the amount being over twice as much as on the latter. This result would have been somewhat unexpected but for the case reported in the last annual report of carbohydrate deficiency producing dieback when the bushes were pruned just after a "rush" of growth. Seasonal carbohydrate deficiency may appear at high elevations in districts subject to pronounced "rushes" of growth, varying in time and intensity according to different conditions. As a safety measure the provision of lungs, preferably in the form of fringe branches, should therefore never be omitted in the pruning operation in such districts.

Indian Jâts of Tea.—Advantage has been taken of the modifications of the Restriction Ordinance and the Plant Pests Ordinance to import on license small quantities of seed of several Indian tea jâts, which will form material for selection work. This privilege is restricted to the Tea Research Institute for scientific work only.

Acknowledgments.—Grateful acknowledgments is made of help received from Mr. R. H. Horne; Messrs. James Finlay & Co., Ltd., and the Superintendent of Galatura Estate; the Superintendents of Sarnia and Diyanila Kele Estates and many others; and also to Dr. Wight of the Indian Tea Association's Scientific Department and Mr. Subba Rao of the U.P.A.S.I. Experimental Station, for information and help willingly given.

F. R. TUBBS,
Plant Physiologist.

REPORT

OF

THE AGRICULTURAL CHEMIST

FOR 1938.

Staff.—Mr. B. T. Schuilling was appointed Field Assistant for work at the sub-stations and commenced duties on 1st June.

Advisory.—662 letters were received and 543 replies despatched. Twenty-five visits were paid to estates for advisory and investigational purposes.

Sub-Stations.—Six visits were made to sub-stations in connection with the work of the department at these stations.

Small-Holdings.—The Agricultural Chemist judged the small-holdings competition in the Yatinuwara Palata of the Kandy District in March and visited 60 small-holdings. Two visits were also paid to the small-holding centres round Baddegama, Southern Province.

Lectures.—Four lectures were given before district branches of the Planters' Associations on various aspects of manuring and cultivation.

The following is a summary of the investigational work carried out in the laboratories and the field during the year :—

The Decomposition of Green Material.—The work on decomposition of vegetable material described in the report for 1937 has been continued by Dr. J. G. Shrikhande. All the commonly used green manures and waste materials have been examined. Particular attention has been paid to the decomposition of tea leaf as in the course of the investigation this material was found to behave in an anomalous manner.

When a plant material decomposes under aerobic conditions the prime agents are fungi which break down the complex tissues of the plant in search of food. The products of decomposition are thus built up into microbial tissue, which lives its allotted span and then in turn is decomposed. Later in the process the active agents are predominatingly bacterial, and these bacteria synthesis the products of decomposition into a sticky mucus material which gives to rotted leaf mould, compost and bulk manure their well-known and easily recognised consistency. In

previous work carried out before joining the Institute's Staff, Dr. Shrikhande had shown that the mucus was produced under conditions of adequate aeration, nitrogen content, and alkalinity, and he devised a method of measuring the index of stickiness by using a standard amount of the 'Compost' at a suitable moisture content as a sandwich-filling between two brass plates. The force necessary to separate the sandwich gives an indication of the extent to which mucus has developed.

All normal materials such as straw, gliricida and weeds develop mucus readily and the more alkaline the reaction the stickier the mucus becomes. Refuse tea, or tea pruning leaf on the other hand develops very little stickiness and needs only about one quarter of the force necessary to overcome the binding effect produced by, for instance, gliricidia. No alteration in alkalinity effects this characteristic, the plain fact being that when tea leaf decomposes it does not produce mucus, or produces only small quantities.

The reason for this exceptional behaviour has been traced to the presence of tannin in the leaf which apparently prevents the requisite bacteria from growing and synthesising the mucus. Gliricidia can be made to behave in exactly the same way if the decomposing mass is kept moist with an aqueous extract of tea leaf instead of plain water. Moreover this anomalous characteristic is shared by other materials which contain appreciable quantities of tannin.

This simple discovery has interesting consequences. In the first place it explains why so many people complained to the Institute that they could not get tea pruning compost to break down unless dung or considerable quantities of other material were added. In point of fact, the tea leaf did break down, but without forming mucus which is a very good diognostic character for well-made compost. Mixed materials would give mucus since the chemical conditions of a heap are not as intimate as in the case just cited where green manure was sprayed with a soluble extract of tannin. Secondly, recent work carried out by Geltzer in Russia, and by E. W. Russell in England suggests that the continual production of mucus may be the main stabilizing factor in the production of good tilth in soils. Thus the criterion of good management may be the provision of adequate supplies of decomposable mucus-forming material rather than the organic matter content in gross. If this were the case green manures would be more valuable than pruning leaf.

The poor production of mucus is not the only anomalous feature of decomposing tea leaf. Studies of the nitrogen balance sheet during aerobic decomposition show that the nitrogen is either unmineralised (*i.e.*, changed into ammonia or nitrite) or is only mineralised to a small degree in very fugitive quantities. Since the amount of organic nitrogen steadily decreases on decomposition the question arises whether an appreciable

quantity of nitrogen is lost as nitrogen gas even under aerobic conditions in which usually such nitrogen would be conserved in the case of other types of material. The cause and mechanism of this behaviour is as yet unknown. Experiments with other nitrogenous materials show that the presence of tannin inhibits mineralisation to some degree, but no case of complete absence of mineral nitrogen has been observed. This may be due to the inherent difficulties of technique, for, in adding tannin to the plant or animal tissues chosen, no such complete propinquity between protein and tannin can be produced as will fairly represent the state of affairs in a tea leaf. For some time it was found impossible to obtain tannin bearing material which contained enough nitrogen to ensure decomposition, but a collection has now been made of young leaves from tannin bearing trees in Peradeniya Gardens and the decomposition and nitrification of these is in progress.

It is premature to evolve hypotheses to account for what happens to the nitrogen in tea leaf when it is returned to the soil as forked-in prunings, but it is obvious that these findings, when developed, may involve some modification of our ideas as to how best to use tea pruning leaf as a conserving agent for soil tilth and nitrogen utilization. The data on which this general account is based will be published in full later. In the meantime the following give some idea of the different behaviour of tea leaf and green manure :—

Nitrogen Transformations in Fermenting Green Material

Material	Original Materials			Fermented Materials			Nitrogen factor	Loss of Nitrogen
	Original N. % (a)	Mineral N. % (added) (b)	Total N. % (c)	Original N. % (d)	Mineral N. (found) (e)	Total N. % (f)	(d-a)	(c-f)
Andropogan ...	1.37	1.09	2.46	1.98	0.41	2.36	+0.61	0.07
Tephrosia vogelii (i)	3.46	1.11	4.57	2.72	1.56	4.28	−0.74	0.29
(ii)	3.46	nil	3.46	2.85	0.67	3.52	−0.61	−0.06
Tea leaf ...	3.19	nil	3.19	2.53	nil	2.53	−0.66	0.66

The Advantages and Disadvantages of Compost.—The use and abuse of compost has received further attention during the year. A memorandum on the subject was presented in November to the Central Board of Agriculture and has appeared in *The Tea Quarterly*, 1938, Part IV.

Well made compost involves the use of basic material in order to give a degree of alkalinity providing optimal conditions for the microbic agents of decomposition. Consequently good compost will of necessity be alkaline. This alkalinity is inimical to the healthy growth of tea which will not tolerate any but acid soils. Used in the field, the complex of compost and soil is seldom so high in its reaction value as to act harmfully, but in

supply holes, nurseries, and especially in supply baskets where the concentration is frequently much higher, it can have and in numerous cases reported to us, has had disastrous results. In order to show the range of reaction value encountered in composts the pH determination was made on 69 samples of compost received from estates.

Number of samples	6	11	7	12	15	18
pH range	Below 6.0	6.0-6.4	6.5-6.9	7.0-7.4	7.5-7.9	8 & above.

Used, therefore, in large quantities with very little dilution by earth all except the first six were unsuitable for treatment in this way. All the six samples afore-mentioned were reported on unfavourably for other reasons.

On the other hand, as an aid to the establishment of green manures, especially dadaps, the use of compost is invaluable. Reference has been made in previous reports to the fact that maana grass and green manures from waste sites was composted by the Adco process (without cattle manure) from 1932 to 1935 and applied to certain areas of experimental sites. The doses were heavy (15 tons per acre per annum) but the dressings were broadcast and not specifically applied to the shade trees. The difference between the dadaps on these areas and in the contiguous areas which were not so treated is very marked.

The non-composted dadaps have either failed to grow and are showing marked eelworm attack or have succumbed and have had to be replanted and are in a very young stage.

The dadaps that are growing well are not immune from eelworm attack but, as they have become well established, the depredations of the nematodes are not so damaging as on the slow growing trees without compost.

Cultivation and Weeding.—Before manuring operations in tea were rationalised as a result of experimental results, there was at any rate a considerable body of general physiological information on which to base manurial policy. In the matter of cultivation no comparable fundamental source of guidance is available. Even for temperate crops the mechanism of cultivation is very imperfectly understood. Apart from a recognition of the need for cultivation it is hard to express an opinion which would meet with majority approval: because so little work has been devoted to the subject views are intensively individualistic.

The paucity of knowledge about the effect of cultivation is due in the main, not to any ill-founded idea that the subject is of little importance, but to the difficulty of devising methods of investigation. Even if certain soil characteristics are measured, there is always the question whether these particular characteristics are of importance to the plant. If we concentrate

on measurements done by a laboratory technique, it is probable that the variations we explore are too small to have much significance to the plant. On the other hand, studies in the field are apt to be so crude in method that the smallest variation we can trace may involve a whole gamut of conditions producing important differences in plant behaviour. Suppose for instance that we could only measure moisture contents above 20 per cent. the problem of studying the moisture relations of soil and plant would be immensely complicated.

Recently implements and methods for examining the condition of the soil *in situ* have been invented and rapidly improved so that there is now some hope of being able to put ideas about cultivation on an evidential basis. In 1936 a field experiment which combined cultivation, weeding and manurial treatments was sarted. After two years during which the effects of treatment on yield had become marked, it was judged that the soil and root conditions produced by the varying cultivation methods would have reached a reasonable state of stability and investigations were put in hand to examine these. The results so far obtained are the subject of a communication at the Tea Research Conference in February, 1939 and will not be detailed in this report. But as a guide to the work the following is an account of the instruments and methods used :—

After searching for a suitable instrument for measuring the degree of compactness of soil, a model designed by Mr. C. Culpin, M.A., Lecturer in Implements and Engineering in the School of Agriculture, Cambridge, was chosen, and made by the engineering laboratories of the University. The principle of the instrument is similar to that outlined in the annual report for 1936, *i.e.*, the penetration of a steel probe into the soil and the measurement of the force necessary to bring about penetration. In Culpin's instrument the force is exerted by turning a handle connected to a worm gear and the measurement of the force is made by means of two coiled springs which are extended in the process. Just as the spring extension of a spring balance measures gravitational pull, so the variation in spring length on the penetrometer measures force applied to overcome the resistance of the soil. By an elegant mechanism the apparatus is made self recording so that a pencil trace on a chart records continuously the spring extension and the depth of penetration. It is thus a simple matter to make 20-25 charts from which to obtain an average of performance on land under any given treatment. A study of any chart so produced places beyond argument the vexed question of the depth of cultivation. The effect of trampling down the surface layers of the soil is also plainly shown by the instrument.

The main value of measurements of soil resistance has been in connection with the study of root distribution; it has enabled us to compare the behaviour of the root system of the tea with the compactness of the soil through which the roots have to spread. Root study is another branch

of agricultural research which has received inadequate attention mainly because of the difficulties in carrying it out efficiently. Generally the procedure has been to wash out the soil from round the roots of a growing plant and to fix the position of the free roots to a wire frame. In order to do this a trench is dug and the picture finally produced is that of a soil and root section. By photography and by plotting the root-frame positions on graph paper a permanent record can be made. This work is intensely laborious in relation to the results achieved and it suffers from the fact that only a few bushes can be done if one is working with a crop such as tea. It is never possible to be satisfied with the representative character of the sample under these circumstances. Further, because one hundred tea bushes treated in this way would be almost fantastically arduous, this approach diminishes the possibility of exploring root systems, not merely under one fixed environmental condition, but in several.

From an agronomic point of view the chief interest of root studies lies in the reaction of roots to soil conditions and to artificial soil disturbance such as is involved in cultivation and manuring. It therefore seemed to us more profitable to sarcifice the detailed but very limited knowledge that frame plotting gives, in favour of obtaining less detailed results under much wider soil and climatic conditions and under varying treatments.

To do this recourse was had to a technique of sampling whereby blocks of soil 8 inches × 3 inches × 3 inches in volume were removed by means of a standard sampling tool. By taking successive three-inch depths a total depth of 24 inches has normally been excavated. From these samples the tea roots have been floated by a method devised by my assistant Mr. E. N. Perera which makes the operation highly efficient and quick. These roots when dried give a basis for comparison both of gross quantities and relative distribution.

By the use of this technique the effect of such varying factors as rainfall, weeds, cultivation, mulching and pruning is being investigated.

MANURIAL EXPERIMENTS.

Nitrogen Response.—The manurial experiments with nitrogen, phosphate and potash is now in its eighth successive year, and continues to provide interesting and useful data. In each of the three cycles to which the data now extend the relative inefficiency of the first year manuring as a producer of crop has been a consistently maintained characteristic. The return of dry matter per pound of nitrogen used in this year increases from 1.4 lb. in the first cycle to 2.8 in the second, but, having a value of 2.3 in the third cycle, shows no sign of maintaining a progressive increase and is on the average only half the value for the later years in the cycle. This now definitely established fact suggested that the reason was connected with the physiological state of the bush immediately after

pruning. It is no use giving manure to a plant if it cannot use it advantageously. If the reserves the plant contains are sufficient to maintain it for some time any excess that is absorbed is physiologically inactive. Tea is by no means peculiar in this respect. The standard agricultural practice in England in wheat growing is to sow in the autumn and to delay nitrogenous manuring till the spring when the plant is in a condition and has the climatic environment for rapid tillering. Winter manuring of wheat has been shown to be inefficient because in its early stages the seed and the soil contain enough to provide for the present need.

But neither this nor any other analogy can be accepted as proof of a proposition, so steps were taken to test the effect of delayed manuring experimentally, and in the present cycle equivalent amounts of nitrogen (with the other manures) were applied at pruning, at three months from pruning and at six months respectively. The results so far accumulated have been reported from time to time in lectures reprinted in *The Tea Quarterly* but are of sufficient interest to record as an interim report here. At the tipping stage no superiority in harvested growth of new shoots owing to *early* manuring had emerged, whilst at the year end the benefit which had accrued from *delay* had reached 76 lbs. per acre and was showing no sign of abating on the plots subject to the six-month postponement.

In the present cycle the doses of nitrogen have been increased so as to bring the highest quantity per acre up to 80 lbs. It will be recalled that in the previous years when 40 lbs. per acre was the upper limit the response in crop was shown to be proportional to the dose. In the present case that statement still holds. Later on when the cumulative effect of the 80 lb. dose has had time to make itself felt this linear response may be modified.

In the report for 1936 it was reported that the yield responses to nitrogen obtained in the Passara experiment that includes deficiency plots were small in comparison with those at St. Coombs. Various probable causes were considered. First was the possibility that the soil conditions were sufficiently good to discount the need for and the response to more manure. This was not likely, however, because the yields were not high in comparison with normal expectation or the rest of the field. Owing to the pruning date at which the experiment was started all manuring has hitherto been done in the North-East Monsoon period, and it is possible that this is a contributory cause. In order to enquire further into this matter the opportunity was taken at the beginning of a new pruning cycle to move the date of manuring to February. In addition, another experiment which had previously reached a suitable stage for reconsideration was converted into a trial in which the effect of nitrogen omission could be observed. In this way it will be possible to see whether the poorness of response to nitrogen is purely local and confined to that experiment, or

whether it is a feature with wider implications. Neither of these two experiments has proceeded far enough yet for detailed report.

Compost.—The trial of compost, green manures and artificial manures alone and in various combinations, which has been in progress at Balangoda for two-and-a-half years has up to now given no concordant results. The weather conditions have been very adverse in the last two seasons and none of the differences is large enough to have any reliance placed on it at all except the response to artificial manure by itself and in conjunction with green manure. The system of management provided for every third plucking to be weighed. Consequently the yields per acre are not available. The percentage yields based on the mean yield for the whole experiment are as follows :—

Percentage Yields in $2\frac{1}{2}$-year period.

	Without Compost	With Compost	With Equivalent green manure
Without artificials ...	91	102	93
With artificials ...	106	98	111
Mean ...	98	100	102

The system of intermittent recording was adopted as a labour-saving expedient for sub-station work. In order to improve accuracy it has now been abandoned, and with the appointment of an additional field assistant complete records are now being kept.

T. EDEN,

Agricultural Chemist.

REPORT

OF

THE BIOCHEMICAL DEPARTMENT

FOR 1938.

Staff.—Mr. Lamb, the Tea Technologist, proceeded on home leave on the 12th October, since which time the Director has been in charge of factory experimentation and advisory work, while Mr. Sreerangachar has supervised the laboratory side of the work.

Correspondence and Advisory Work.—458 inward letters were received and 429 despatched while 370 samples were received for examination. 15 visits were paid to estate factories by staff of the department. Of the samples analysed, 119 were in connexion with a special investigation carried out at the request of the Ceylon Association in London.

A summary of much of the work proceeding in this department up to the time of Mr. Lamb's departure on leave was given in a series of reports printed in *The Tea Quarterly*, Vol. XI, Part III, September, 1938, to which readers are referred. To avoid unnecessary duplication, the present report will therefore be considerably condensed, the salient points of the above reports being dealt with and the results brought up to the end of the year.

Manufacture.—Under manufacturing experiments, considerable attention has been given to the subject of rolling and, in particular, to more detailed work with the Clivemeare roller to which some reference was made in last year's report

The Clivemeare roller consists essentially of two smooth even-surfaced rollers, rotating in opposite directions and so set that the distance between the rollers can be adjusted within very fine limits. The rollers rotate at a speed of about 120 revolutions per minute, and it will be appreciated that when the setting is a fine one the leaf is subjected *momentarily* to an enormous pressure. The smaller the gap, the greater of course is the pressure, and there is a corresponding increase in the brightness and strength of the liquors. Tea rolled in this way gives after fermentation a beautiful coppery infusion which is also very even.

At the highest pressures, however, owing to the disintegration of the leaf, the appearance of the made tea is unsatisfactory, being of a very flaky character, which was not favoured by the market either in London

or Colombo — particularly the latter. It at once became obvious, therefore, that various modifications in the details of manufacture would have to be tried out, having as their object improvement in appearance while retaining so far as possible the even bright infusions and strong liquors. After a large series of experiments a routine was evolved in which a lightly withered leaf containing about 60 per cent moisture was used and in which two rolls in an ordinary type of roller were given to the leaf *after* it had passed through the Clivemeare machine. Conventional rolling *before* "Clivemearing" was found to be less satisfactory. Working in this way, the appearance of the tea has been markedly improved, though the Clivemeare Flowery Pekoe is still of rather a rough character. It will no doubt, however, be possible to improve this grade. As now being made, the teas have proved acceptable in regard to appearance to the London Market, though Colombo which is particularly sensitive in respect to this character, still has criticisms to make. Both markets however, are agreed as to the excellent infusions and coloury liquors of the Clivemeare teas. This is particularly striking in the case of the Fannings concerning which a recent London report says "the infused leaf is almost perfect in coppery evenness."

Matters having got to this stage, it was decided to test out this type of manufacture on a larger scale. Two invoices were therefore prepared for sale in London, one of normal manufacture and the other made by the Clivemeare process as outlined above. The two methods of manufacture were carried out on alternate days so that any accidental variations in the nature of the green leaf would be averaged out so far as possible. Both invoices were made during the height of the South-West Monsoon when the leaf was naturally of rather poor quality. In some respects this was perhaps an advantage, because it is particularly at such times, when flavour is absent and liquors often thin and uninteresting, that a process such as the Clivemeare might be expected to give valuable results.

The grade percentages obtained by the two types of manufacture were as follows :—

GRADING PERCENTAGES

	Clivemeare Manufacture Invoice 17	Normal Manufacture Invoice 18
B.O.P. ...	54.2 per cent.	59.3 per cent.
F.P. ...	—	19.8
P. ...	17.4	0.6
O.P. ...	—	0.5
B.P. ...	—	1.2
Fannings ...	16.9	13.0
Dust ...	8.2	3.2
B.M., etc. ...	3.3	2.4

The normal invoice, "Trinor," comprised 54 chests consisting of B.O.P., F.P. and B.O.P. Fannings, there being insufficient dust for packing the necessary number of chests. The "Clivemeare" invoice, "Trimeare," was of the same number of chests but included dust as well as the above grades. Details of valuations and of the sale prices realised are given in the following table :—

Grade	Invoice 18 "Trinor" Lbs.	Valuation	Price	Invoice 17 "Trimeare" Lbs.	Valuation	Price
B.O.P. ...	3,750	1/3½	1/3	3,300	1/3-1/3½	1/4¼
B.P. ...	1,260	1/2½-1/3	1/2½	570	1/3	1/2¾
B.O.P. Fgs. ...	1,080	1/3½	1/3¾	996	1/3½-1/4	1/4¾
Dust ...	—	—	—	600	1/1	1/2
Average ...	—	—	1/3	—	—	1/4

While there was some difference amongst brokers' opinions, vide *Tea Quarterly,* 1938, page 119, the sale resulted in a difference of 1d. per lb. in favour of the Clivemeare invoice and this would have been increased slightly if the normal invoice had included dust. The premium was undoubtedly due to the character of the infusions and the strength and colour of the Clivemeare teas, and it may be of interest to speculate as to the manner in which these qualities are produced. In the first place it is of interest to note that the increased colour of the cup does not appear to be due to a greater weight per cup of soluble materials passing into the brew. This is illustrated in the following figures which were obtained from samples in which the tea was extracted for 30 minutes with boiling water to obtain complete extraction.

Sample	% Extract	% Caffeine	% Theotannin
Normal B.O.P. ...	41.0	3.20	21.0
Clivemeare B.O.P. ...	40.0	3.04	20.3

Both samples were made from the same batch of green leaf. Similarly, when samples were extracted for three successive 5-minute periods the results were as follows :—

Sample	% Water-soluble material extracted. 1st brew	2nd brew	3rd brew	Total
Normal B.O.P. ...	25.4	7.7	3.1	36.2
Clivemeare B.O.P. ...	26.1	7.3	2.5	35.9

The better and stronger colour of the Clivemeare must, therefore, be due to some change in the character of the soluble materials and not to their total amount. In other words a better fermentation has taken place.

In regard to to the evenness of the infusions, there can hardly be any doubt that this is a direct result of the more complete "bruising" which the leaf receives as it passes through the Clivemeare roller. The liberation of the reacting substances is effected almost instantaneously with the result that fermentation begins at the same time in the different portions of the flush.

This view received confirmation from the higher enzymic activity found in the leaf leaving the Clivemeare roller as compared with that normally obtained, leading to more rapid fermentation in the Clivemeare leaf. It is quite possible of course that the same results could be obtained by other methods, but the simplicity of the Clivemeare process is undoubtedly a strong point in its favour.

The promising results obtained have led to a further series of experiments with further minor modifications in procedure and further invoices are to be manufactured in the flavoury season for sale in London. This should provide a most valuable comparison as the reports on these breaks should indicate whether the increased colour and strength is obtained at the expense of quality and flavour.

The position is now such that it may be worth while to record the present programme of manufacture by the Clivemeare process. The process is simple but attention to detail is required otherwise appearance may suffer and the leaf tend to dry brown instead of black, rendering it practically unsalable.

A wither is taken such that the leaf contains about 57-60 per cent moisture. The withered leaf is fed through the Clivemeare roller very thinly, the rate of feed being about 270 lbs. per hour. Actually at St. Coombs 200 lbs. is passed through in 45 minutes which provides one charge for the normal roll that follows and fits in with the drying programme. The roller setting is about 6 or 7 turns back from full pressure, but this may vary slightly according to the condition of the leaf, the criterion being that the leaf should be thoroughly crushed but not disintegrated. The Clivemeare leaf is fed into the normal Jackson roller as it passes through the Clivemeare machine, and rolled with the pressure cap just riding on the surface of the leaf, the rolling period being 45 minutes calculated from the time the pressure cap is first lowered. The leaf is then put over a roll-breaker with No. 5 mesh. From 45 to 50 per cent dhool (A) is obtained which is put out to ferment, while the bulk is given a second roll under hard pressure for 25 minutes in an "Economic" roller with Lamont-Michie battens. On roll-breaking this material only about 2 to 3 per cent of big bulk (C) is obtained which is added to the next batch of Clivemeare leaf.

The fermentation period is shorter than with St. Coombs normal manufacture and will usually be from 2½ to 3 hours from the time pressure is applied in the first roll.

Grading is carried out on a Michie sifter equipped with square-perforated aluminium sieves. The big bulk is winnowed free of fibre, very light reds and flaky leaf in a Brown's winnower with the air lever fully open. After picking free from stalks and heavy fibre, the leaf is then cut twice or three times as required and amalgamated with the cut leaf from the 1st and 2nd dhools (*q.v.*) and sifted, using a 2½ mm. sieve in the top tray. The tea remaining in the broken mixed boxes after winnowing contains fannings and dust which are separated with a hand sieve.

The first dhool is sifted separately from the second, a 2½ mm. sieve being used for the separation of Pekoe and B.O.P. The leaf passing over the sieve is sifted a second time over the same mesh. That which again passes over is picked free of stalk and heavy fibre, cut once, and amalgamated with the cut leaf from the second dhool and big bulk. The B.O.P. fraction, passing through 2½ mm. but over a 1 mm. sieve has a fair amount of flat fannings leaf. This is separated by resifting, using a 1 mm. sieve in the top tray. The leaf passing over this sieve is B.O.P. and is winnowed separately from the B.O.P. from the other dhool and the big bulk. When winnowing, the fan damper should be almost fully closed. During the sifting of the first dhool and big bulk, the second dhool is picked over and then passed over the 2½ m.m. sieve. The B.O.P. fraction, passing through the 2½ mm. but over the 1 mm. sieve is resifted using a 1 mm. sieve in the top tray. The B.O.P. passing over this sieve is amalgamated with the B.O.P. fractions from the cut leaf obtained above and the amalgamated fractions winnowed with the fan damper at 7.

The leaf passing over the 2½ mm. sieve is picked over, cut, and amalgamated with the cut leaf of the other dhools and sifted again over 2½. The fraction passing over is the Pekoe which is winnowed and picked over before going to the bins.

The fraction passing through the 2½ mm. but over the 1 mm. sieve is B.O.P. from cut leaf and is treated as described earlier.

All the B.O.P's are well bulked after winnowing.

The fractions passing through the 1 mm. sieve when the uncut B.O.P's from both dhools are passed over this size sieve form the fannings.

The fannings and dust from the dust box of the sifter are separated by hand sieves. The amalgamated fannings fraction are well bulked and winnowed twice, the fan damper being set at 7 on the first occasion and then at 8.

All dust is well bulked and winnowed with the fan damper fully closed. Small No. 60 sandy red dust is discarded with the broken mixed.

Working on the above lines, the grading will work out approximately as shown below. For comparison the present grading of the normal manufacture is shewn also.

GRADING PERCENTAGES

	Clivemeare Tea	Normal Manufacture
B.O.P. ...	56	55
F.P. ...	13	12
O.P. ...	—	2
B.P. ...	—	9
P. ...	—	4
Fannings ...	21	12.5
Dust ...	6	3
B.M. and waste ...	4	2.5

The main difference is the higher percentage of Fannings in the Clivemeare tea with a corresponding reduction in O.P., B.P. and P.

Other Rolling Experiments.—Experiments have continued comparing the effect of different types of battens and, in particular, the differences obtained using "twisting" and "cutting" types of battens. The effect of different pressure periods has also been examined. The general scope of these experiments and the preliminary results obtained prior to October last were explained in considerable detail in *The Tea Quarterly* for last September, Vol. XI, Part III, pages 135-144, and as fuller results will be published shortly it is not proposed to discuss this further now.

Firing Experiments.—A few years ago, arising largely from a number of complaints from London of soft teas, there was a tendency to adopt high firing temperatures. Little evidence was adduced to show that the deterioration of the teas in question was due to faulty firing, and the view of the Institute was that the trouble was, in fact, brought about by unsatisfactory packing leading to the teas picking up an excessive amount of moisture in transit. Since then complaints of softness have been less frequent and at the present time the tendency is rather to try out considerably lower firing temperatures.

The Institute has therefore been carrying out for some little time a series of experiments in which comparisons have been made between teas fired at 160°, 190° and 210°F. It is obvious, of course, that if the rate of spreading and fan speeds be maintained constant, an increase in the inlet temperature will shorten the time required to dry the tea to a predetermined

moisture content and *vice versâ*. If, however, it is required to keep the duration of firing constant, this can be achieved by alterations in the rate of spread and/or fan speeds. Both these sets of conditions have been studied. The working arrangements have, therefore, been as follows:—

Series I.—Load and air flow constant and time varied, so that with each firing temperature the tea was dried to a moisture content of 3 per cent. The actual firing times were as follows:—

Firing Temperature		Duration of Firing
160°F.	...	42 mins.
190°F.	...	21 ,,
210°F.	...	16 ,,

Series II.—The time of firing was kept consant at 21 minutes and the rates of spreading were adjusted so that the moisture content of the discharged tea was again 3 per cent.

The above experiments are being repeated under different seasonal conditions. Though the series is not yet complete, there seems a tendency amongst the brokers who have reported on the samples to prefer the teas fired at the lowest temperature 160°F. Those fired at 210° have throughout received the lowest valuations in the series. The following figures are representative of the relative valuations obtained:—

Series A. Load and air-flow constant.

Firing Temp.	Average Valuations		
	A. Colombo (cents)	B. London (pence)	C. After storage for 4 weeks Colombo (cents)
160°F. ...	78	15½	79
190°F. ...	77½	15	78
210°F. ...	74½	14½	76

Series B. Time of firing constant at 21 minutes.

Firing Temp.	Average Valuations		
	A. Colombo (cents)	B. London (pence)	C. After storage for 4 weeks Colombo (cents)
160°F. ...	75	16¼	78
190°F. ...	74	15¼	77
210°	72	14½	75

An important fact in the above reports is the second valuation made in Colombo after the above teas had been stored for six weeks. There is no evidence of the low fired teas having "gone off."

Maturing and Storage Experiment.—Considerable variations occur in the figure to which tea is dried in different factories and it seemed of interest to examine what effect these residual differences in moisture content might have on the teas when stored.

A batch of tea was dried to a moisture content of 3 per cent. From this one sample was further dried to 1.7 per cent, while in other samples the moisture content was raised to 5, 6, and 7 per cent respectively. All the samples were then stored for four weeks after which they were sent for valuation. Two sets of such valuations are quoted below :—

Sample	Average valuations. Cents Series I	Series II
Original Tea. Moisture content 3% ...	80	85½
— Moisture reduced to 1.7% ...	73¼	83¼
— Moisture raised to 5% ...	71¼	84¾
— Moisture raised to 6% ...	68¾	82
— Moisture raised to 7% ...	68	80¾

The figures given for the samples dried down to 1.7 per cent moisture must at present be taken with reserve. The reduction in moisture content was carried out by chemical means and in certain cases this lead to difficulties which may have had an effect on the valuations of the samples concerned.

The figures, however, clearly shew the unfavourable effect of increasing moisture content.

Factory Hygiene.—In an interesting paper by Mr. Benton, the Bacteriologist of the Tocklai Experimental Station, the view was put forward that the dull soft teas with poor infusions which are often a feature of monsoon manufacture were in large part due to bacterial infection during manufacture, and could to a large extent be eliminated by more careful attention to the conditions of the factory plant, utensils and floors. In particular Mr. Benton recommended regular flaming of all plant in order that harmful bacteria arising from particles of stale leaf, old juice, etc., might be destroyed.

After seeing Mr. Benton's report, some preliminary experiments have been carried out at St. Coombs to ascertain whether such measures would lead to an improvement in the teas produced, a burner of the type used in India, and known as the Hauck Burner, being obtained.

The earlier tests showed little difference between the teas made after careful flaming of all plant by such a blow lamp and those made without special precautions. In a later series of experiments, however, the results were in favour of flaming, the valuations being shown below. In these particular experiments a portion of the tea was fermented for 24 hours as it was expected that this would emphasize any deleterious effect due to bacterial contamination.

	Average Valuations			
	Colombo (Cents)		London (Pence)	
	After flaming	Without flaming	After flaming	Without flaming
Leaf fermented for normal period :—				
B.O.P. ...	80½	78½	1/3⅛	1/2¼
Fannings ...	73¼	72	1/4	1/3½
Leaf fermented for 24 hours :—				
B.O.P. ...	73½	72½	1/2¾	1/2
Fannings ...	68	66¼	1/3⅛	1/2⅞

After storage of the above teas for six weeks in glass bottles the following Colombo valuations were given :—

	After flaming	Without flaming
Leaf fermented for normal period :—		
B.O.P. ...	74	71
Fannings ...	73¾	73

Further repetitions of the above experiments will be required to confirm or otherwise the results quoted above.

Meantime arrangements had been made for a test of the Hauck Burner to be carried out in a factory at a lower elevation, as it was to be anticipated that with the higher temperatures prevailing there the effect of any bacterial contamination would be more marked. I am indebted to the superintendent of the estate in question for the following preliminary report :—

"I have experimented carefully with the burner, which is still in use and have come to the following conclusions :—

1. Its thorough use has a beneficial effect on infusions which are considerably brighter.

2. It appears advisable to flame machinery, etc., at least twice in a working day of 12 hours.

3. 'Fermentation' can be prolonged. Samples fermented 4, 8, 10 and 20 hours were inspected by my agents. The 10 and 20-hour infusions were also bright, but the tea 'went off' after a few days.

4. The present type of burner is too large and can be dangerous after a time even with expert use.

5. No kerosene taints have been noticed.

I think it can be safely said the flaming of all machinery, etc., in "the rolling room will improve infusions where conditions are not already ideal. I do not know how the wooden parts of the machinery will stand up to being flamed with this large burner two of three times daily, and the teamaker and the assistant teamaker who now do the flaming find the intense heat rather a strain. There is a risk of fire, and any increase of price due to bright infusion is hardly noticeable on the local market at present."

The comments in this report relative to the risk of using this particular type of burner in the average Ceylon factory agree with our experience at St. Coombs, and it seems hardly likely that flaming will be widely adopted until a safer means of carrying this out has been devised.

Miscellaneous Factory Experiments.—Grading tests are in progress with circular-stamped aluminium sheets. Up till recently aluminium sheet with square-stamped perforations has alone been available. This has proved very satisfactory indeed, but it is understood that sheet with circular perforations will be cheaper to produce.

A new type of sifting machine, the Arnott Filtrate Sorter made by Messrs. Walker & Greig Ltd. is also under test.

Monel metal and cupro-nickel have been tested in regard to their suitability for use in tea machinery for which they have obvious advantages from the hygiene point of view. So far fermentation tests alone have been carried out and both the above materials appear to be suitable.

Various types of locally made chests of the momi type have been under examination. Those made from albizzia wood have been of very good quality and free from defects. In the case of a number of other local woods there was in many of the samples evidence of borer attack and some care will have to be taken in eliminating such species.

Masonite presdwood has been found to be suitable as a picking over surface. Details regarding this will be found in *The Tea Quarterly*, 1937, Part III, page 157.

Convenient methods for taring tea chests for the London market have also been devised, details of which have already been published.

The Biochemical Department is responsible for the routine manufacture of leaf from the manurial, pruning and cultivation experimental plots, and has more recently devised means for the manufacture of leaf from individual bushes in connexion with the selection work of the Plant Physiologist. Comment on this work has already been made in the report of the Director.

The Chemistry of Tea Manufacture.—Reference to the joint work to be carried out by Ceylon, India and the Netherlands East Indies has already been made by the Director in his report. Meantime, the work on the constituents of green leaf and on the enzymes concerned with manufacture which was outlined in the annual report for 1937 (pages 65-71) continues to make progress. This work is, however, so technical in character that it cannot usefully be described in the space available in an annual report. A discussion of these results will therefore be deferred until the investigation is more complete.

Acknowledgments.—Individual acknowledgments have already been made by the Director to the many individuals and firms who have so generously assisted us by reports and comments on experimental samples. It is to be hoped that undue advantage has not been taken of their good nature, but without such help progress in our manufacturing experiments would be quite impossible and it is a pleasure to acknowledge in this report how freely such assistance has been forthcoming.

ROLAND V. NORRIS,
I/C. Biochemical Department.

REPORT

OF

THE SMALL-HOLDINGS OFFICER,

GAMPOLA, FOR 1938.

The competition that was organised last year among the small-holders in tea in the Yati-Nuwara area was brought to a close in February. This competition was run on similar lines to those held in the other two chief headmen's divisions, namely Uda-Palata and Uda-Nuwara.

It has been made possible with the organising of these competitions to create more enthusiasm among the small-holders in the working of their tea holdings towards adopting the more improved methods of cultivation.

Dr. Eden, the Agricultural Chemist, very kindly undertook to do the final judging this year, which was done during the second week in March. We had with us Mr. Lester-Smith, the Soil Conservation Officer of the Department of Agriculture, who accompanied us on these inspections.

The distribution of prizes and certificates to the successful candidates was held at the Government Vernacular School at Kadugannawa on the 3rd of April. Dr. and Mrs. R. V. Norris and Dr. T. Eden were present. Mrs. Norris very kindly consented to give away the prizes. We were unfortunate not to have had our Chairman and the Ratemahatmaya present at this function.

A large gathering of small-holders from Yati-Nuwara were present. The prize distribution brought to a close another year's work, from which small-holders derived a number of benefits and improved their tea holdings considerably.

The success of this competition was due entirely to the ready co-operation of the chief and minor headmen and the members of the Village Committees of Yati-Nuwara, to whom I am very grateful and offer my sincere thanks.

Demonstration Work.—These competitions are organised to help demonstration work and encourage small-holders to adopt the more improved methods of draining and pruning. The "Reverse Slope" drain is advocated as the best method of draining on small-holdings, it is easy to adopt and helps considerably in the prevention of soil erosion.

The "Rim-Lung" method of pruning has been advocated as the most suitable for small-holdings and the majority of small-holders adopt it.

With the aid of these competitions we now find in every village in these three Divisions, Uda-Palata, Udu-Nuwara and Yati-Nuwara, small blocks of tea worked on the methods advocated by the Institute. These blocks help to serve as demonstrations to other owners of tea holdings and thus tend to improve conditions in village tea gardens.

Green Manures.—The usefulness of growing green manures on holdings has been fully realised by all small-holders and today the majority of holdings have a good cover of gliricidia and dadaps. Wherever possible a free supply of seed and cuttings are issued to small-holders.

Weather.—Weather conditions have been normal during the year.

Tea Restriction.—The Tea Restriction Scheme has been extended over another period of five years and we are at the end of the first year in the new period. There has been no change in the scheme and tea coupons still continue to be sold as small-holders find it more profitable to do so. Though coupons continue to be sold, small-holdings have not been totally negelected in this district to the extent that is sometimes stated.

This could be proved by the number of appeals that were lodged at the beginning of the year for special assessments under the new Tea Restriction Scheme.

The majority of small-holders were successful in their appeals and had an appreciable increase granted in their assessments. A number of these appeals were the direct result of these organised competitions and competitors who had done good work but who were not successful in winning prizes were rewarded with increases in their assessments.

The granting of re-assessmnets to small-holdings has been a great encouragement to them towards better work and it is encouragement of this kind that will help to improve the conditions of village tea holdings. There has been no trade in the small-holders' green tea leaf due to its being unsalable without coupons. The unsalability of green tea leaf has brought about a forced rest, which has helped considerably to improve the tea on all small-holdings.

Bought Leaf Factories.—Due to tea restriction these factories continue to lie idle, as the manufacture of uncouponed leaf is not profitable. This has brought about a considerable amount of unemployment in the villages, as most of these factories employed village labour.

General.—Another competition has been organised in Kandukara Pahala Korale in Uda-Palata and Kandu Palata Korale in Udu-Nuwara. The areas are smaller than in previous years, giving more time for the

supervision of the areas that have already been worked. Once again we have had the ready co-operation of Village Committees in these areas and funds have been voted by them for prizes.

A special visit was made to Balangoda at the request of the Ratnapura District Agricultural Association. A number of meetings and demonstrations in draining and pruning were carried out during this visit.

Visits were also made to a number of villages and small-holders met individually, their difficulties discussed, and suggestions made as to how best they could improve their tea holdings. There were quite a number of small-holders who were keen on learning the new methods and improving their holdings. With more supervision and encouragement the small-holdings in this area could also be improved with considerable benefits to their owners.

The Kandy Branch of the Co-operative Society held its Annual Conference this year in August. I addressed them on "How to maintain and work Small-Holdings in Tea."

Finally, I must thank the chief and minor headmen of Uda-Palata, Udu-Nuwara and Yati-Nuwara, also the Chairmen of Village Committees of these three areas for their co-operation in my work.

R. L. ILLANKOON,
Small-Holdings Officer.

The Tea Research Institute of Ceylon.

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